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(54) **SENSOR ACTUATOR WITH DRIVER AND CAMERA MODULE INCLUDING SAME**

(71) Applicant: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Suwon-si (KR)

(72) Inventors: **Jae Woo Jun**, Suwon-si (KR); **Yun Kyoung Choi**, Suwon-si (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR)

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H04N 23/54 (2023.01)

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CPC ***H04N 23/687*** (2023.01); ***H04N 23/54*** (2023.01)

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See application file for complete search history.

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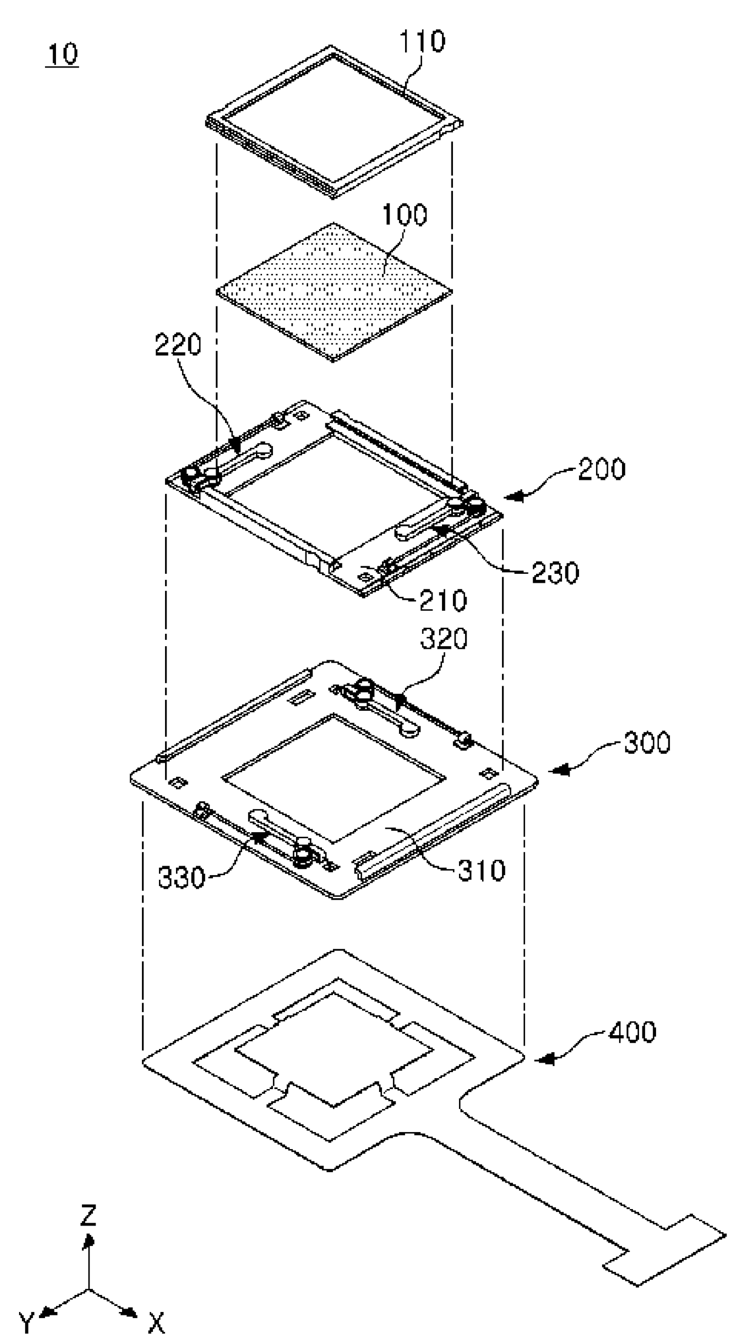
Primary Examiner — Padma Haliyur
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

A sensor actuator includes an image sensor configured to convert incident light into an electrical signal, and first and second driving parts, configured to move the image sensor in first and second directions, respectively, each of the first and second driving parts includes one or more drivers each includes a wire having a change in length configured to move the image sensor. The one or more drivers in the second driving part is configured to move the image sensor and the first driving part together, and the first and second directions are different from each other.

16 Claims, 10 Drawing Sheets



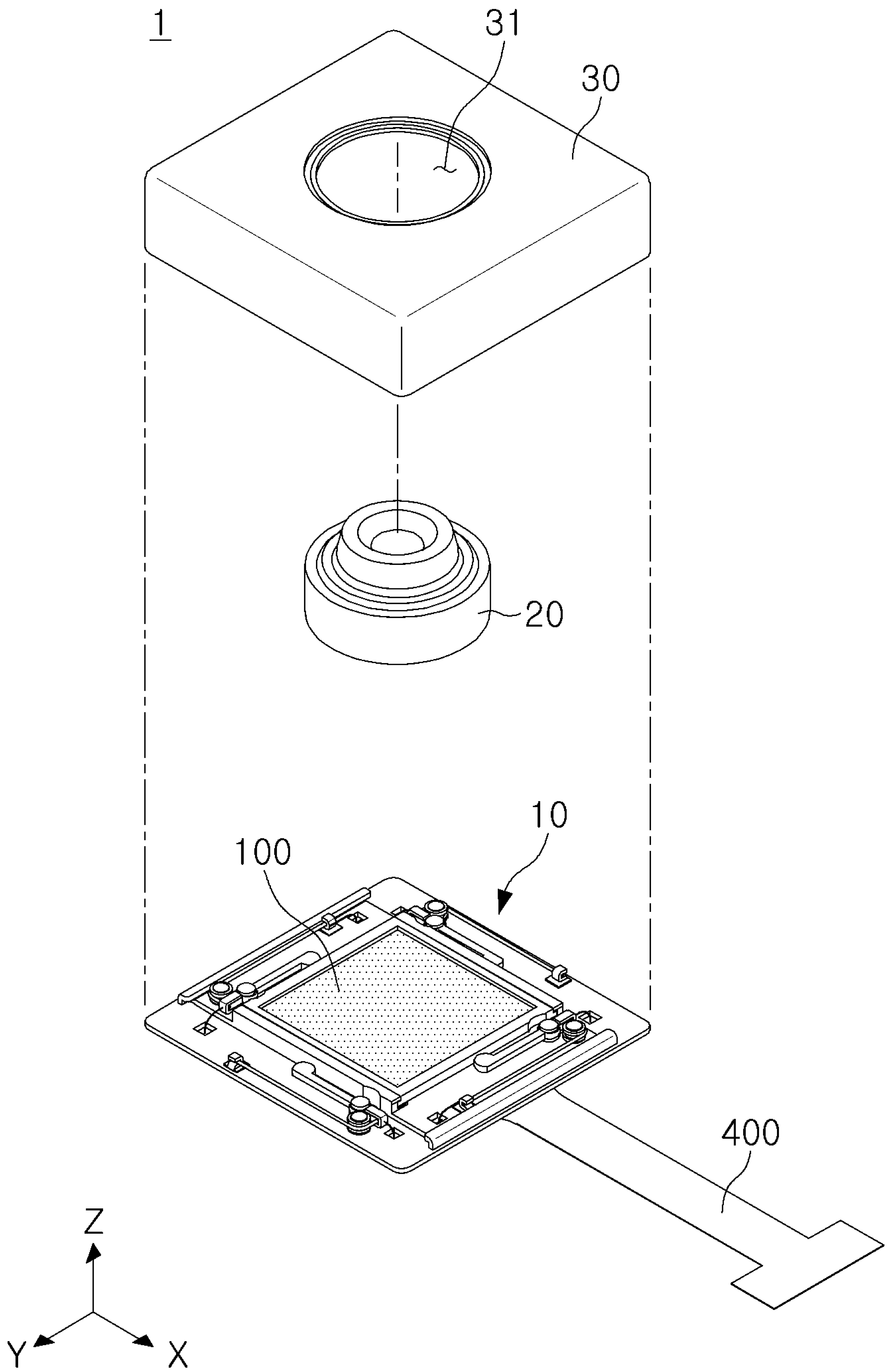


FIG. 1

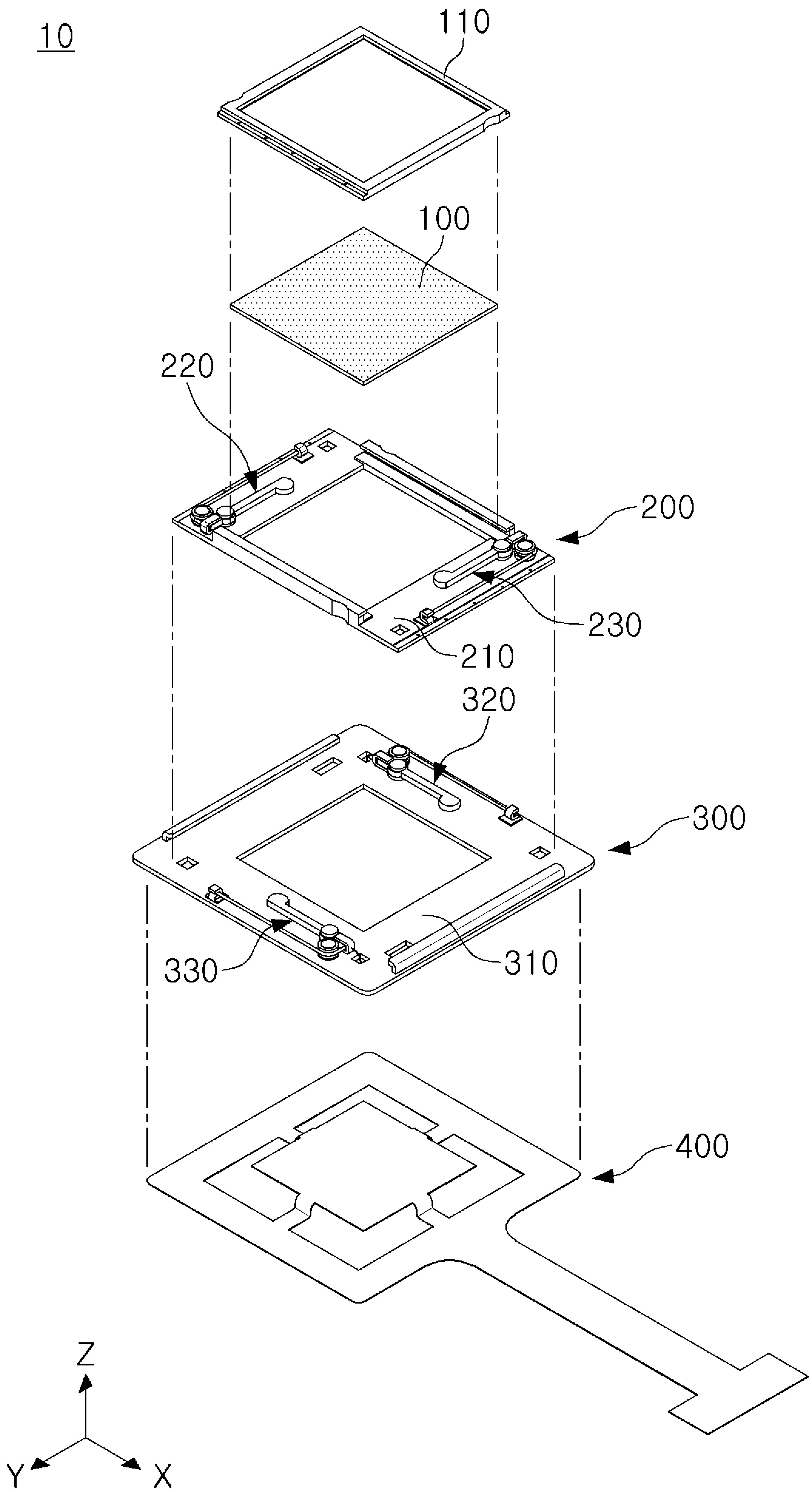
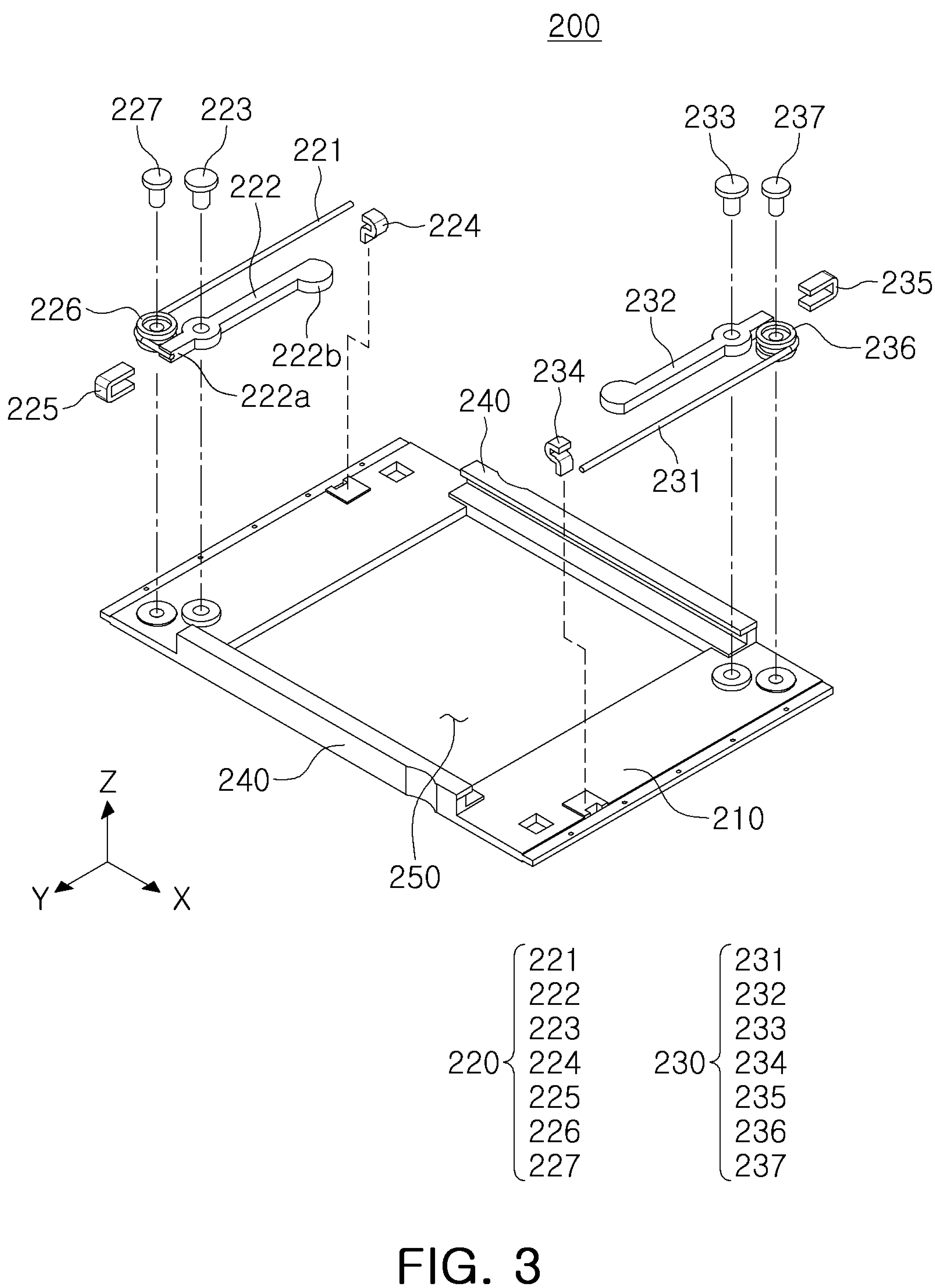


FIG. 2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226
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233
237
235
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236
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240
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250
210
Z
Y
X
220
221
222
223
224
225
226
227
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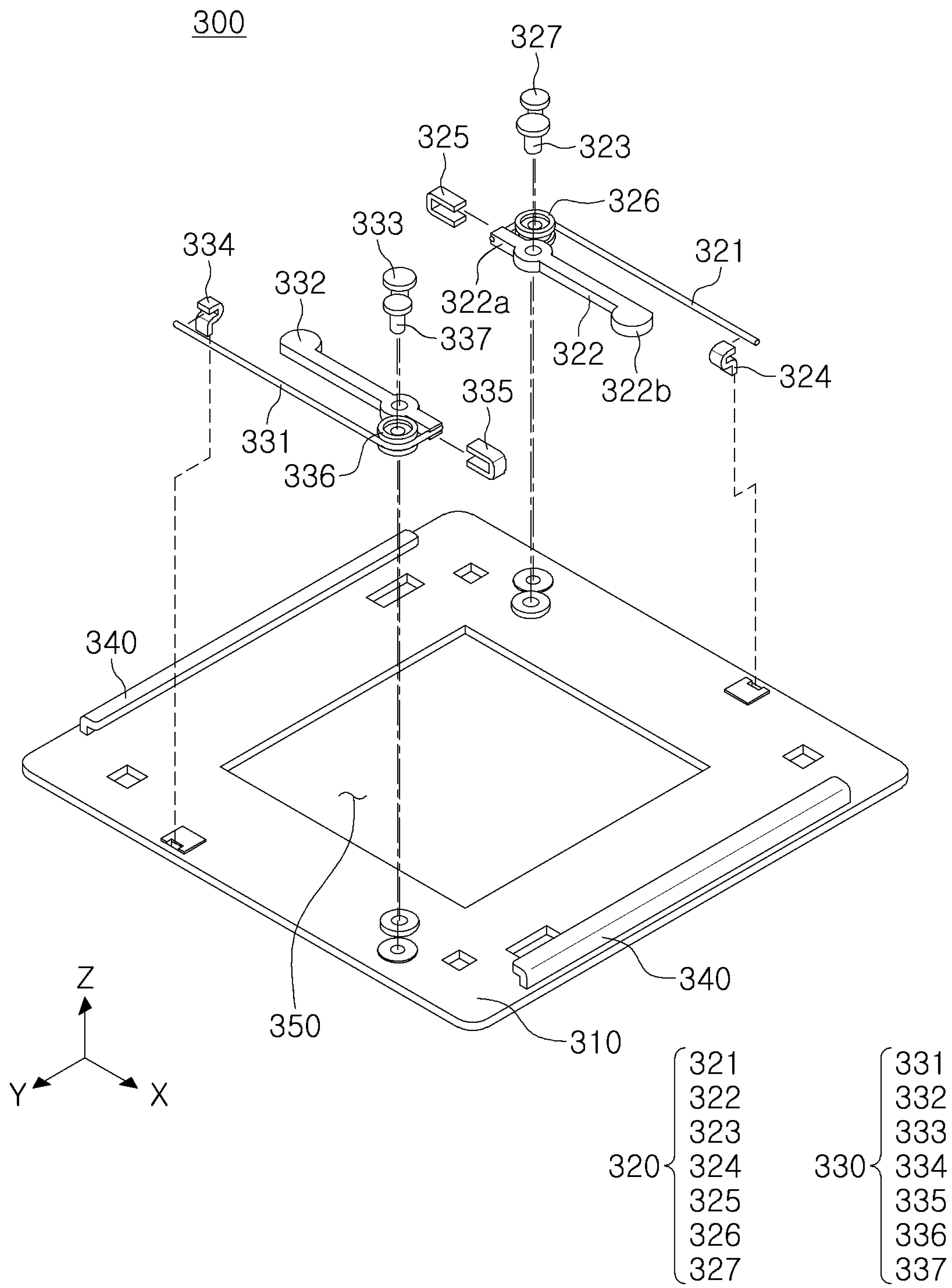
231
232
233
234
235
236
237

FIG. 3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334
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322
335
324
322b
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340
350
340
310
Z
Y
X
320
321
322
323
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326
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330
331
332
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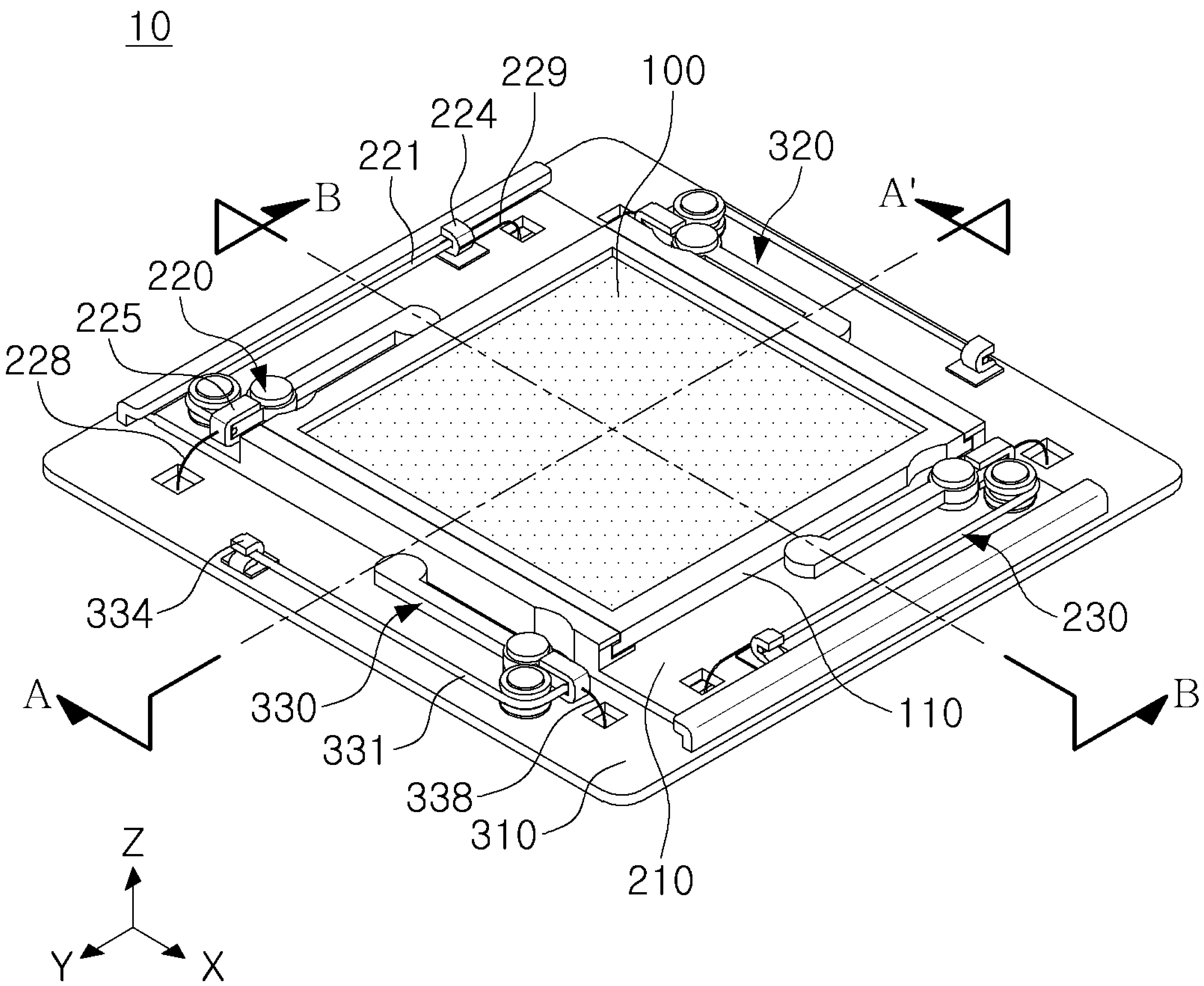
334
335
336
337

FIG. 4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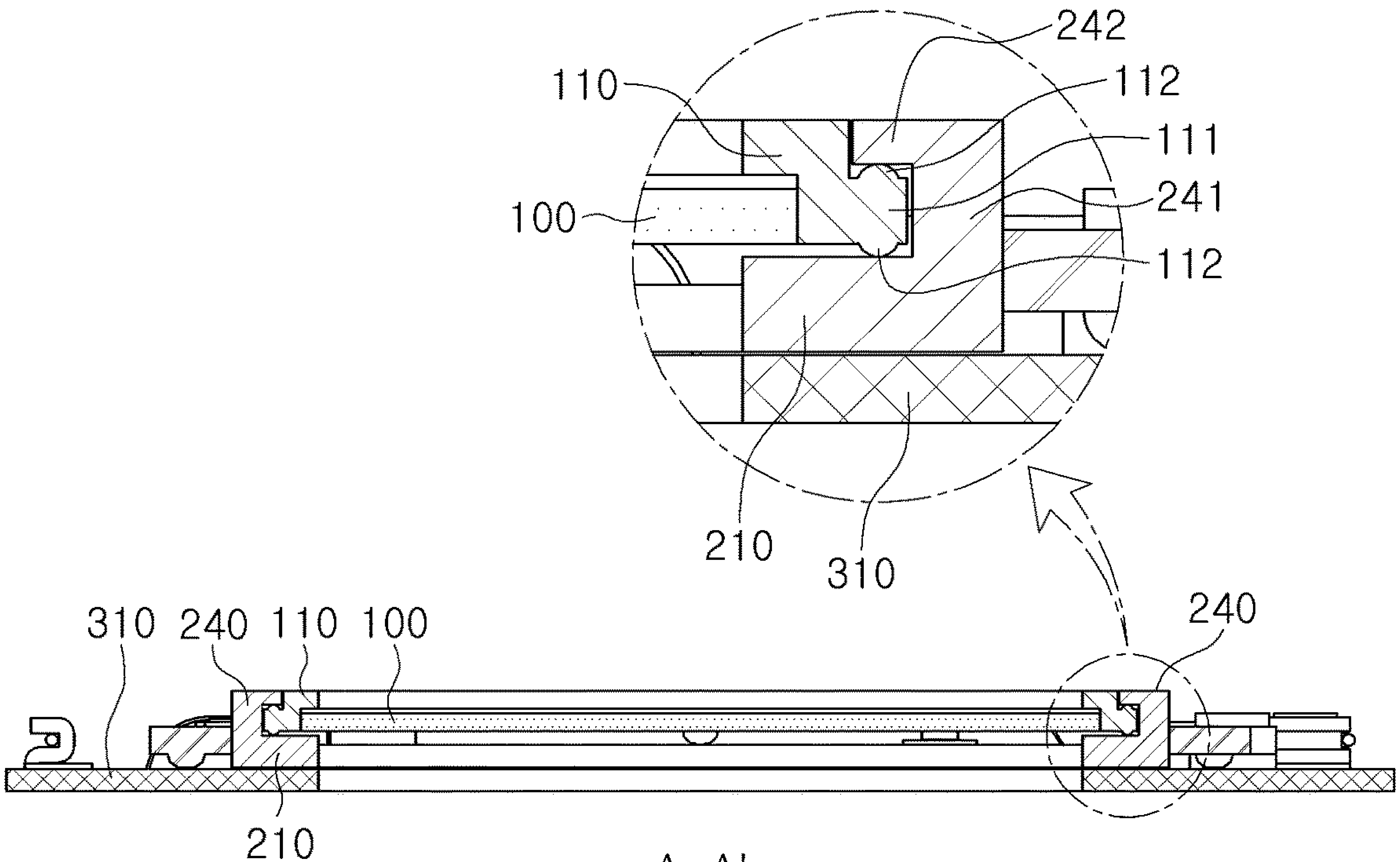
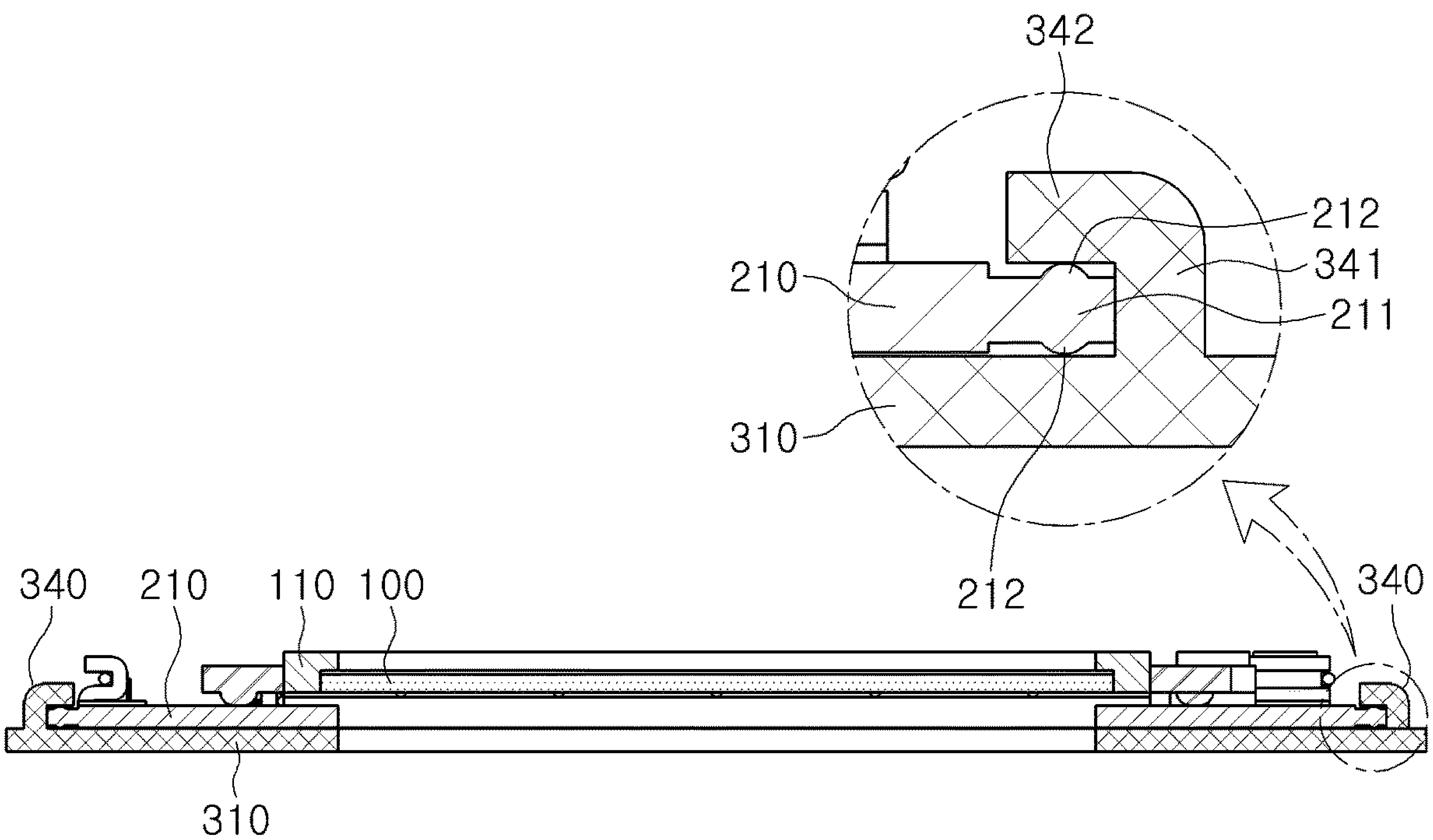
229
224
100
221
320
B
A'
220
225
228
334
230
330
A
B'
331
110
338
310
210
Z
Y
X

FIG. 5



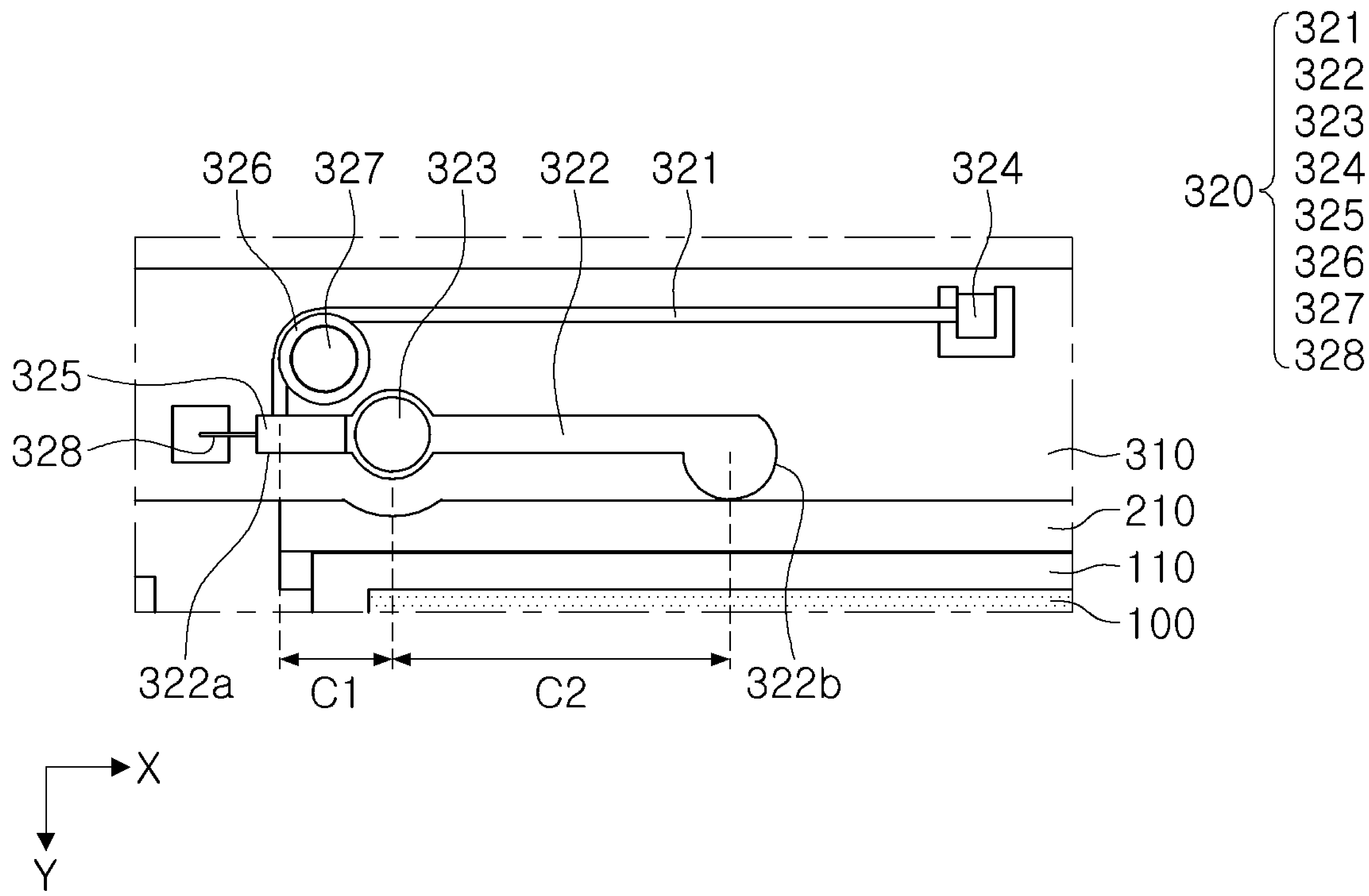
A-A'

FIG. 6



B-B'

FIG. 7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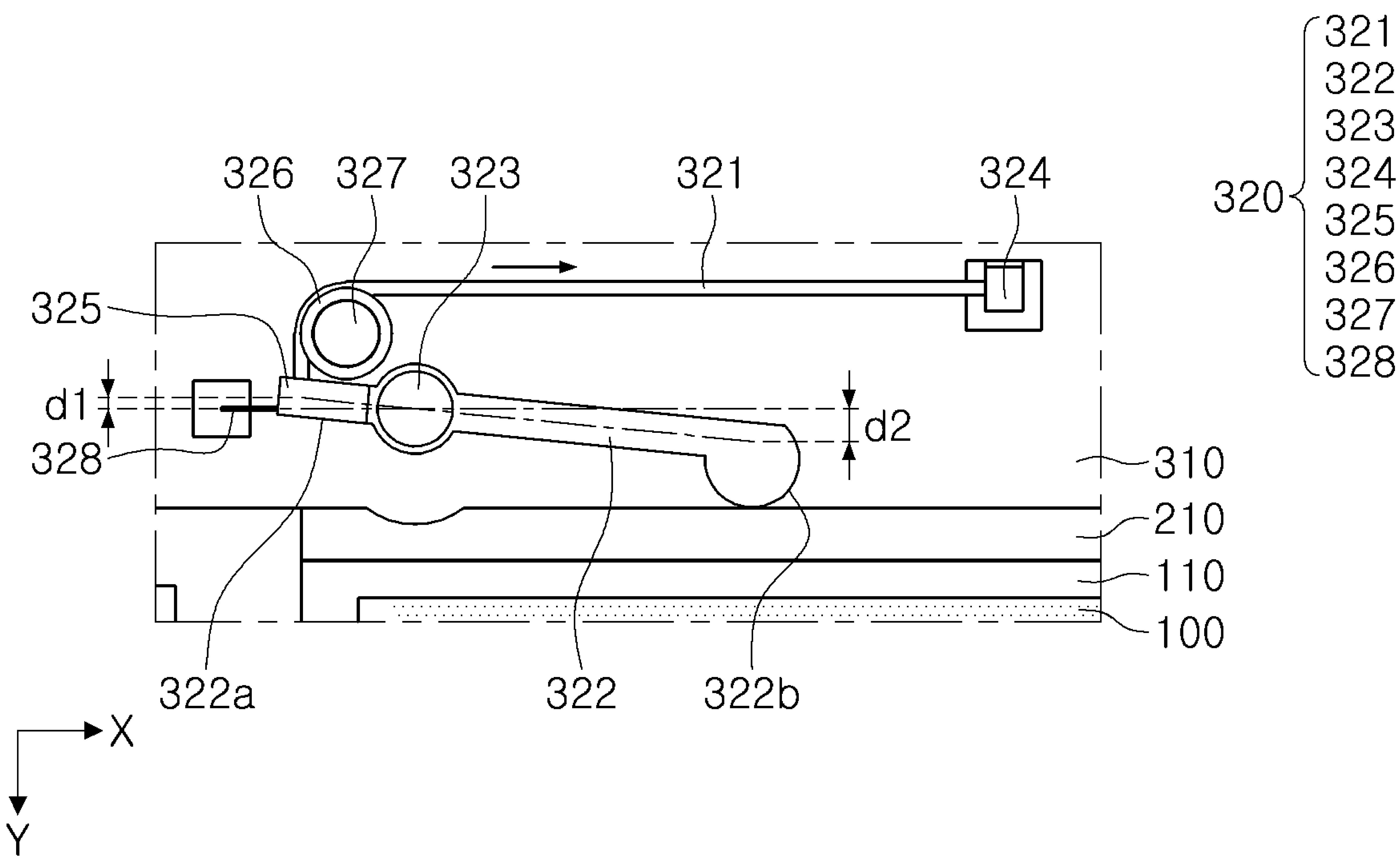
110
100
322a
C1
C2
322b
X
Y

FIG. 8A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326
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323
321
324
325
d1
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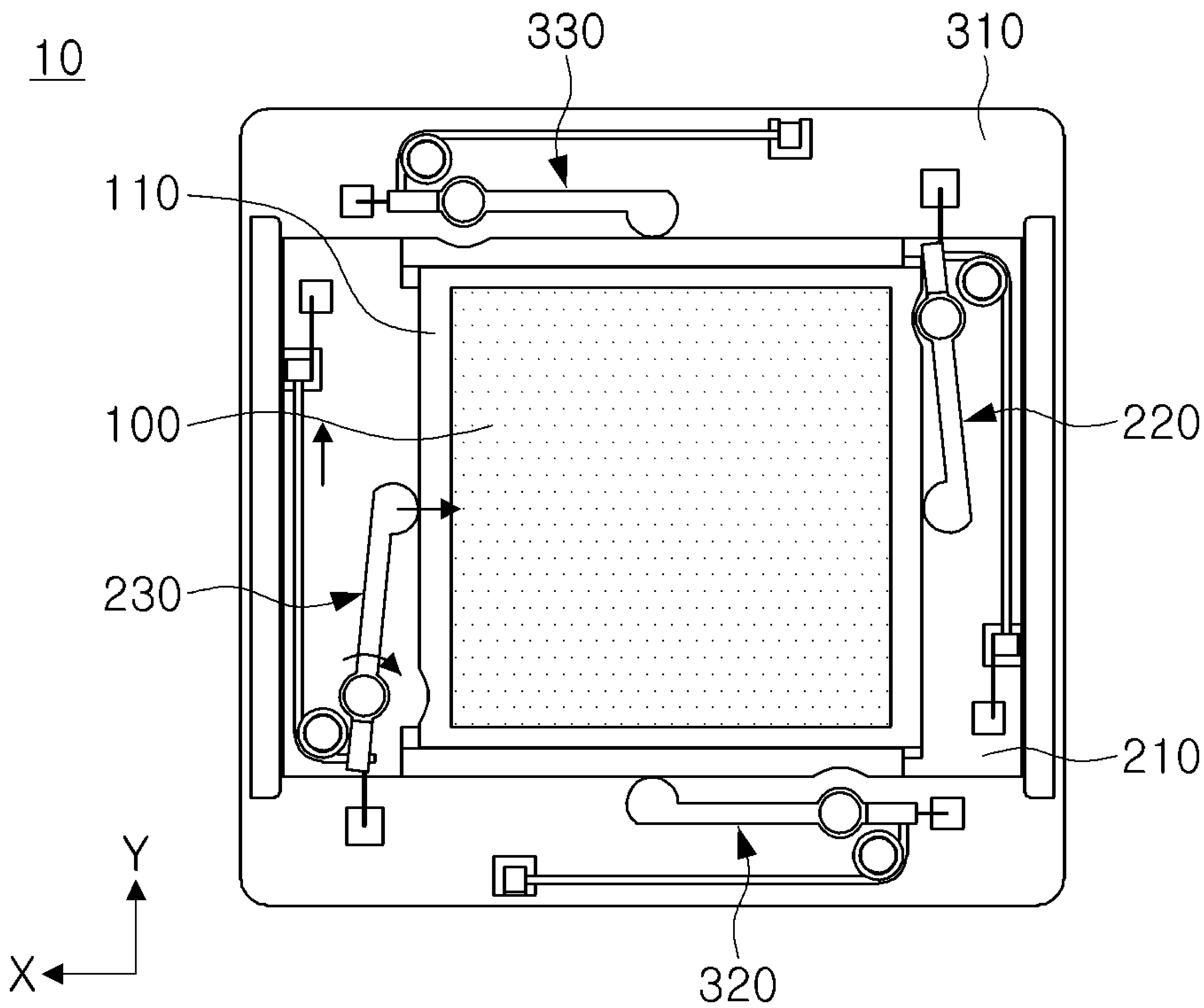
d2
310
210
110
100
322a
322
322b
X
Y

FIG. 8B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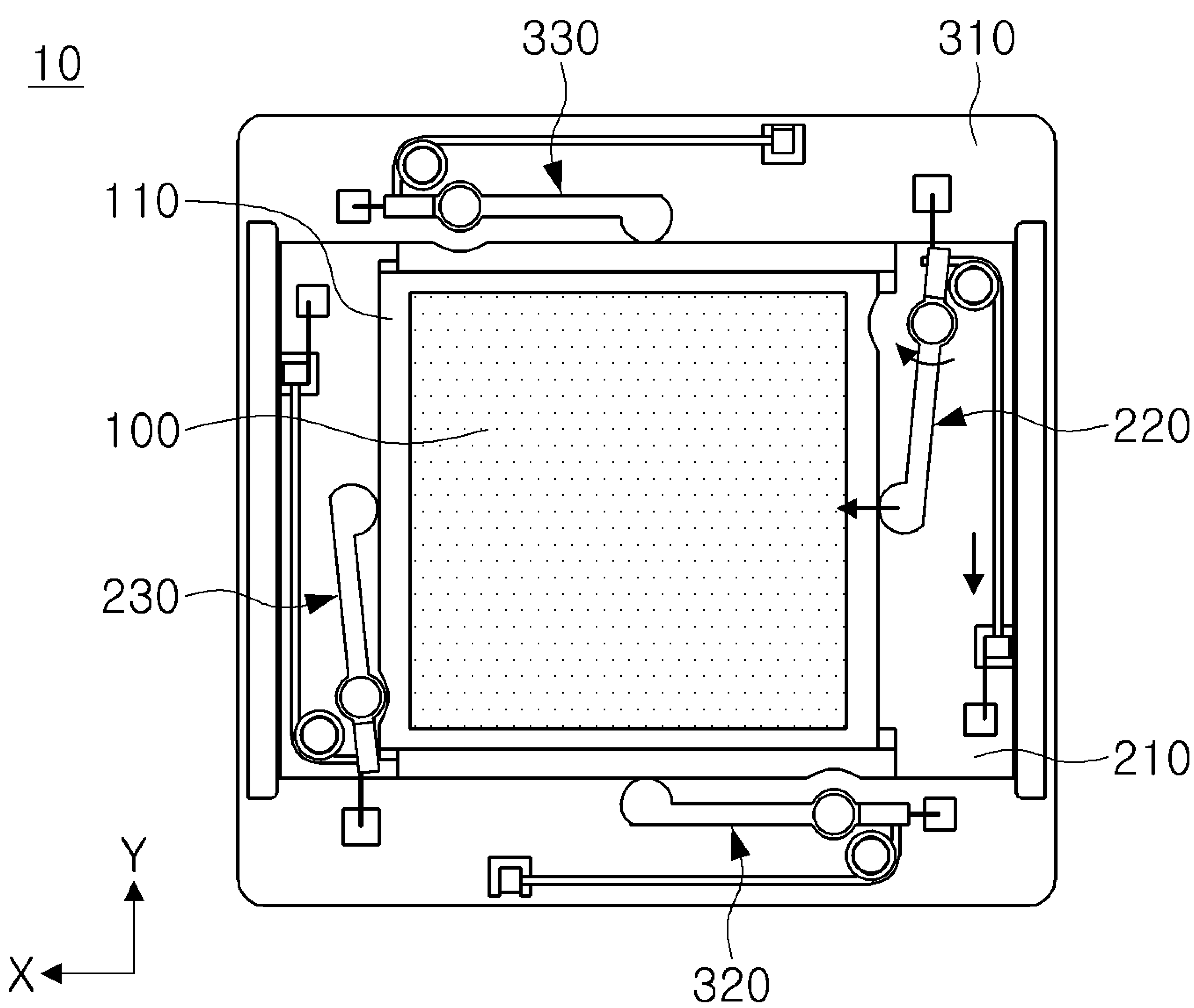
330
310
110
100
220
230
210
Y
X
320

FIG. 9A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330
310
110
100
220
230
210
Y
X
320

FIG. 9B

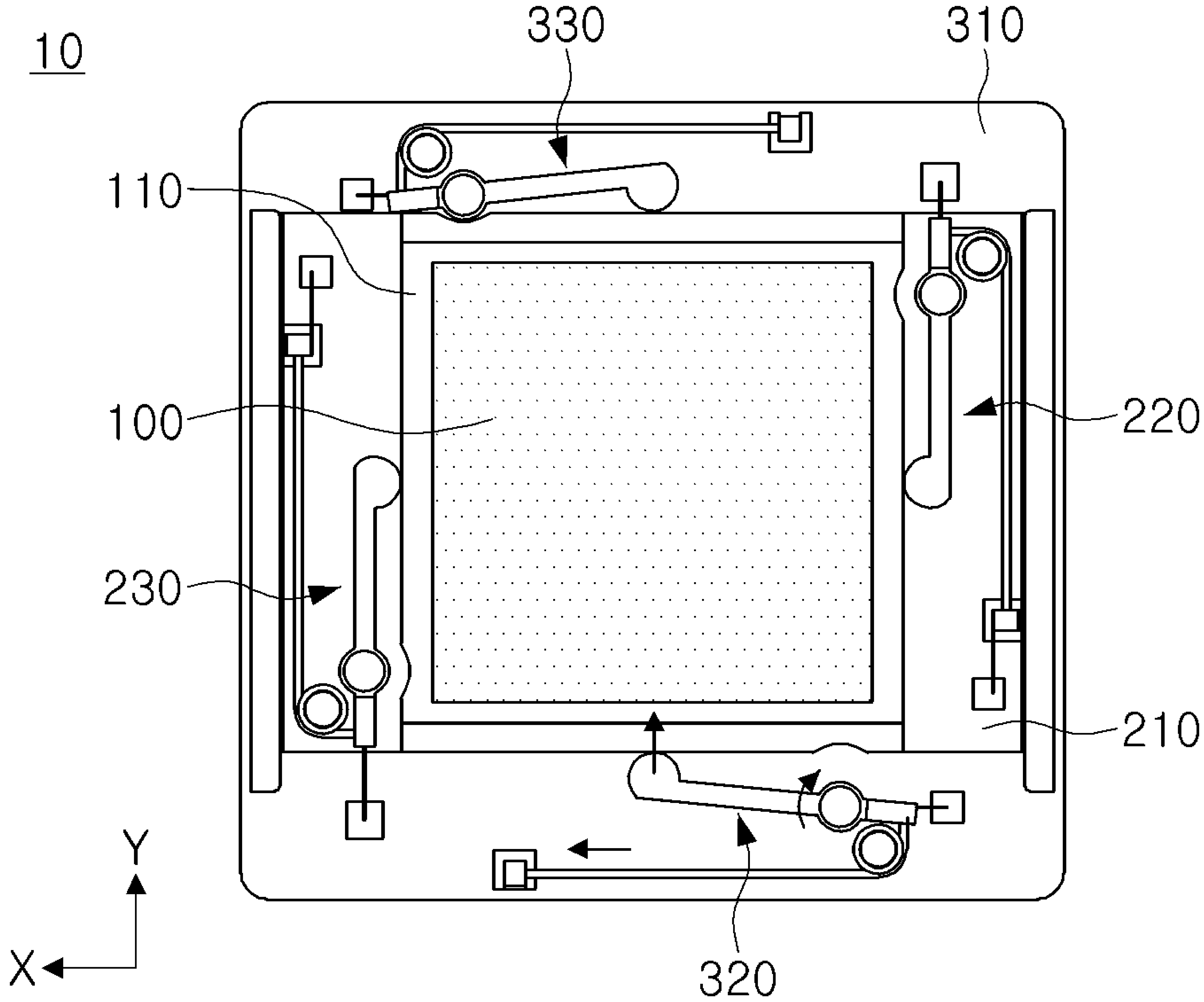
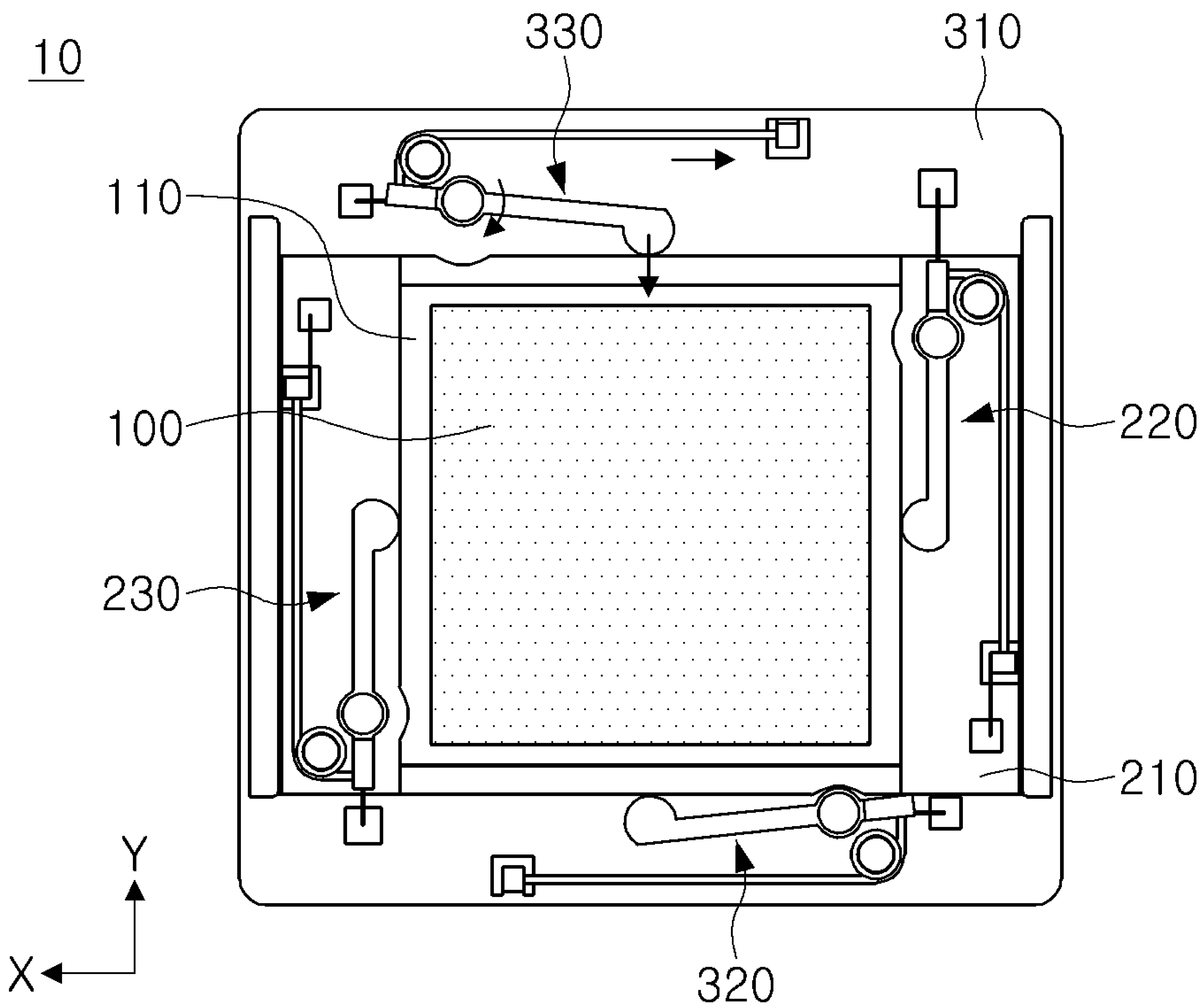

10
330
310
110
100
220
230
210
Y
X
320

FIG. 9C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310
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100
220
230
210
Y
X
320

FIG. 9D

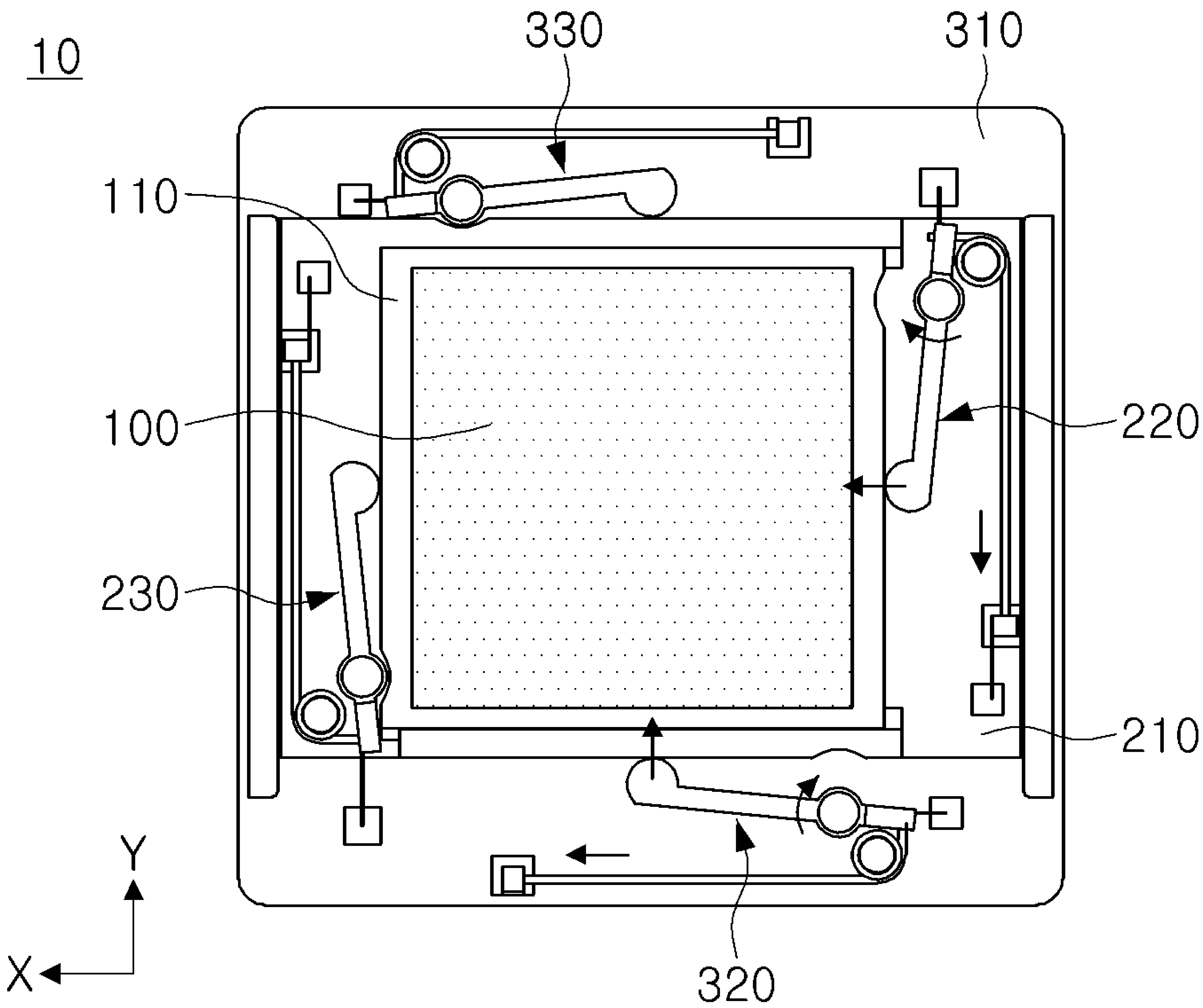
10
330
310
110
100
220
230
210
Y
X
320

FIG. 9E

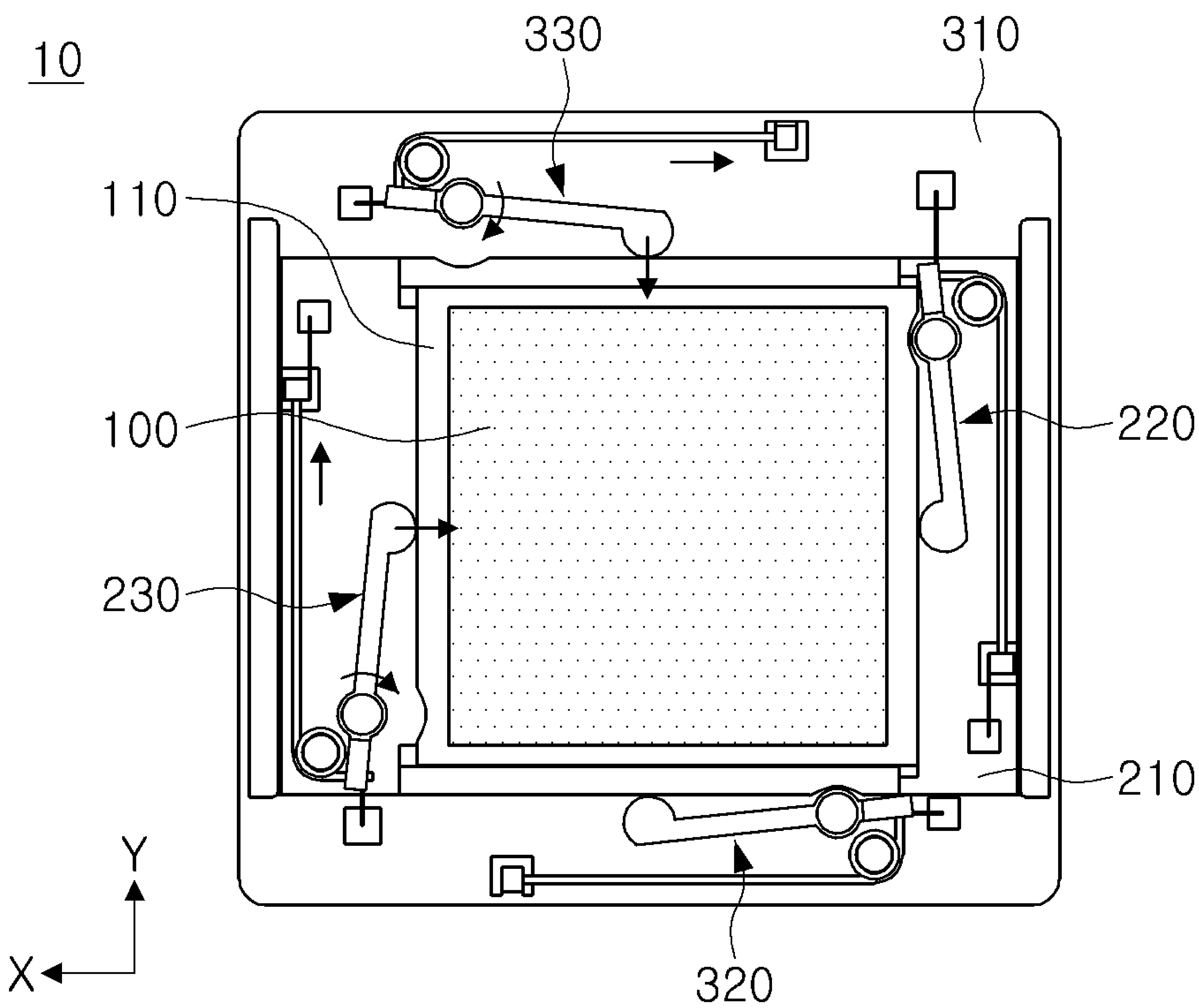
10
330
310
110
100
220
230
210
Y
X
320

FIG. 9F

SENSOR ACTUATOR WITH DRIVER AND CAMERA MODULE INCLUDING SAME

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application claims the benefit under 35 USC 119(a) of Korean Patent Application No. 10-2021-0076846 filed on Jun. 14, 2021, in the Korean Intellectual Property Office, the entire disclosure of which is incorporated herein by reference for all purposes.

BACKGROUND

1. Field

The present disclosure relates to a sensor actuator and a camera module, including the same.

2. Description of Related Art

Recently, cameras have been basically adopted in portable electronic devices such as smartphones, tablet PCs, and laptop PCs, and an autofocusing (AF) function, an optical image stabilization (OIS) function, a zoom function, and the like have been added to the camera provided in the mobile terminals.

In addition, a camera module has been provided with an actuator moving a lens or an image sensor directly or moving a reflective module, including a reflective member in an indirect manner for optical image stabilization. Typically, the actuator is capable of moving the lens, the image sensor, or the reflective module using a driving force caused by a magnet and a coil.

In a case in which a conventional actuator including a magnet and a coil is used to move a plurality of lenses or an image sensor, it is difficult to produce a camera module with a small size due to the sizes of the magnet and the coil included in the actuator.

In addition, with respect to the actuator, including a magnet and a coil, there is concern that an electromagnetic field generated by the magnet and the coil may have an electromagnetic influence on the other components of the camera module or other electronic components outside the camera module.

In addition, in a case in which the actuator, including a magnet and a coil is used to move a plurality of lenses or an image sensor, consumption of power is severe and precise control is difficult.

SUMMARY

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

In one general aspect, a sensor actuator includes an image sensor configured to convert incident light into an electrical signal, and first and second driving parts, configured to move the image sensor in first and second directions, respectively, each of the first and second driving parts includes one or more drivers each includes a wire having a change in length configured to move the image sensor. The one or more drivers in the second driving part is configured to move

the image sensor and the first driving part together, and the first and second directions are different from each other.

The one or more drivers may further include a lever, connected to the wire, configured to rotate around a rotation axis based on the change in length of the wire to move the image sensor, and a lever shaft forming the rotation axis.

A moving distance of the image sensor based on the change in length of the wire may be greater than an amount of the change in length of the wire.

The lever may include a connection portion connected to the wire, and a contact portion contacting a plate provided with the image sensor. The rotation axis may be between the connection portion and the contact portion.

In the lever, a distance from the connection portion to the rotation axis may be smaller than a distance from the contact portion to the rotation axis.

The contact portion of the lever may have a curved surface.

The first direction may be a first axis perpendicular to an optical axis, and the second direction may be a second axis perpendicular to both the optical axis and the first axis.

The first driving part may include a movable plate configured to movably accommodate the image sensor, a first driver, disposed on the movable plate, configured to move the image sensor in a positive direction of the first axis, and a second driver, disposed on the movable plate, configured to move the image sensor in a negative direction of the first axis.

The sensor actuator may further include a sensor plate surrounding a perimeter of the image sensor. The movable plate may include a first guide portion extending in the direction of the first axis. The first guide portion may include a first extension portion extending from the movable plate in a direction of the optical axis, and a first bent portion bent from the first extension portion in a direction intersecting the optical axis. At least a portion of the sensor plate may be inserted between the first bent portion and the movable plate to move the sensor plate in the direction of the first axis.

The sensor actuator may further include a friction reducing member on the portion of the sensor plate inserted between the first bent portion and the movable plate.

The second driving part may include a base configured to movably accommodate the movable plate, a third driver, disposed on the base, configured to move the movable plate in a positive direction of the second axis, and a fourth driver, disposed on the base, configured to move the movable plate in a negative direction of the second axis.

The base may include a second guide portion extending in the direction of the second axis. The second guide portion may include a second extension portion extending from the base in a direction of the optical axis, and a second bent portion bent from the second extension portion in a direction intersecting the optical axis. At least a portion of the movable plate may be inserted between the second bent portion and the base to move the movable plate in the direction of the second axis.

The sensor actuator may further include a friction reducing member disposed on the portion of the movable plate inserted between the second bent portion and the base.

The first, second, third, and fourth drivers may be driven independently of each other.

In another general aspect, a camera module includes a lens module including one or more lenses, and a sensor actuator, configured to receive incident light passing through the lens module. The sensor actuator including an image sensor, a movable plate, and a base stacked in a direction of an optical axis, a first wire configured to move the image sensor with respect to the movable plate in a direction of a first axis perpendicular to the optical axis, and a second wire configured to move the movable plate with respect to the base in a direction of a second axis perpendicular to both the optical axis and the first axis. The first wire is disposed on the movable plate, and the second wire is disposed on the base.

At least a portion of the first wire may be disposed to extend in the direction of the second axis, and at least a portion of the second wire may be disposed to extend in the direction of the first axis.

Other features and aspects will be apparent from the following detailed description, the drawings, and the claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is an exploded perspective view of an example of a camera module, according to one or more embodiments.

FIG. **2** is an exploded perspective view of an example of a sensor actuator, according to one or more embodiments.

FIG. **3** is an exploded perspective view of an example of a first driving part included in the sensor actuator, according to one or more embodiments.

FIG. **4** is an exploded perspective view of an example of a second driving part included in the sensor actuator, according to one or more embodiments.

FIG. **5** is a perspective view of the sensor actuator, according to one or more embodiments.

FIG. **6** is a cross-sectional view taken along line A-A' of FIG. **5**;

FIG. **7** is a cross-sectional view taken along line B-B' of FIG. **5**;

FIGS. **8**A and **8**B are reference views explaining the driving of a driver included in the sensor actuator, according to one or more embodiments.

FIGS. **9**A to **9**F are reference views explaining the driving of the sensor actuator, according to one or more embodiments.

Throughout the drawings and the detailed description, the same reference numerals refer to the same elements. The drawings may not be to scale, and the relative size, proportions, and depiction of elements in the drawings may be exaggerated for clarity, illustration, and convenience.

DETAILED DESCRIPTION

The following detailed description is provided to assist the reader in gaining a comprehensive understanding of the methods, apparatuses, and/or systems described herein. However, various changes, modifications, and equivalents of the methods, apparatuses, and/or systems described herein will be apparent after an understanding of the disclosure of this application. For example, the sequences of operations described herein are merely examples, and are not limited to those set forth herein, but may be changed as will be apparent after an understanding of the disclosure of this application, with the exception of operations necessarily occurring in a certain order. Also, descriptions of features that are known after understanding of the disclosure of this application may be omitted for increased clarity and conciseness.

The features described herein may be embodied in different forms, and are not to be construed as being limited to the examples described herein. Rather, the examples described herein have been provided merely to illustrate some of the many possible ways of implementing the methods, apparatuses, and/or systems described herein that will be apparent after an understanding of the disclosure of this application.

Throughout the specification, when an element, such as a layer, region, or substrate, is described as being "on," "connected to," or "coupled to" another element, it may be directly "on," "connected to," or "coupled to" the other element, or there may be one or more other elements intervening therebetween. In contrast, when an element is described as being "directly on," "directly connected to," or "directly coupled to" another element, there can be no other elements intervening therebetween.

As used herein, the term "and/or" includes any one and any combination of any two or more of the associated listed items.

Although terms such as "first," "second," and "third" may be used herein to describe various members, components, regions, layers, or sections, these members, components, regions, layers, or sections are not to be limited by these terms. Rather, these terms are only used to distinguish one member, component, region, layer, or section from another member, component, region, layer, or section. Thus, a first member, component, region, layer, or section referred to in examples described herein may also be referred to as a second member, component, region, layer, or section without departing from the teachings of the examples.

Spatially relative terms such as "above," "upper," "below," and "lower" may be used herein for ease of description to describe one element's relationship to another element as shown in the figures. Such spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, an element described as being "above" or "upper" relative to another element will then be "below" or "lower" relative to the other element. Thus, the term "above" encompasses both the above and below orientations depending on the spatial orientation of the device. The device may also be oriented in other ways (for example, rotated 90 degrees or at other orientations), and the spatially relative terms used herein are to be interpreted accordingly.

The terminology used herein is for describing various examples only, and is not to be used to limit the disclosure. The articles "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "includes," and "has" specify the presence of stated features, numbers, operations, members, elements, and/or combinations thereof, but do not preclude the presence or addition of one or more other features, numbers, operations, members, elements, and/or combinations thereof.

Due to manufacturing techniques and/or tolerances, variations of the shapes shown in the drawings may occur. Thus, the examples described herein are not limited to the specific shapes shown in the drawings, but include changes in shape that occur during manufacturing.

The features of the examples described herein may be combined in various ways as will be apparent after an understanding of the disclosure of this application. Further, although the examples described herein have a variety of configurations, other configurations are possible as will be apparent after an understanding of the disclosure of this application.

FIG. **1** is an exploded perspective view of an example of a camera module **1** according to one or more embodiments.

The camera module **1**, according to one or more embodiments, may be provided in a portable electronic device such as a mobile communication terminal, a smartphone, or a tablet PC.

The camera module **1**, according to one or more embodiments, may include a lens module **20** including one or more lenses, a sensor actuator **10** provided with an image sensor **100** converting light incident through the lens module **20** into an electrical signal, and a case **30** covering the lens module **20** and the image sensor **100**.

One or more lenses for imaging a subject may be accommodated in the lens module **20**. In a case in which a plurality of lenses are arranged, the plurality of lenses may be mounted inside the lens module **20** and aligned in an optical axis direction (e.g., a Z-axis direction). The lens module **20** may include one or more cylindrical lens barrels, each hollow.

The camera module **1**, according to one or more embodiments, may include a lens driver (not shown) moving the lens module **20**. The lens driver (not shown) may move the lens module **20** in the direction of an optical axis (Z-axis) to perform a focusing function or a zoom function, or move the lens module **20** in a direction (e.g., X-axis or Y-axis) perpendicular to the optical axis (Z-axis) to perform an optical image stabilization function. Alternatively, the lens driver (not shown) may rotate the lens module **20** about the optical axis (Z-axis), or rotate the lens module **20** about an axis (e.g., X-axis or Y-axis) perpendicular to the optical axis (Z-axis) to perform an optical image stabilization function. That is, the lens driver (not shown) may include a focusing unit performing focusing and an optical image stabilization unit performing optical image stabilization.

The sensor actuator **10** may include an image sensor **100** and one or more driving parts (e.g., **200** and **300** in FIG. **2**) moving the image sensor **100**.

The image sensor **100** may convert light incident through the lens module **20** into an electrical signal. For example, the image sensor **100** may include a charge coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS). The image sensor **100** may be electrically connected to a circuit board **400**, and accordingly, the electrical signal converted by the image sensor **100** may be output to the outside through the circuit board **400**.

The sensor actuator **10**, according to one or more embodiments, may further include a filter (not shown) provided adjacent to the image sensor **100**. For example, the sensor actuator **10** may be provided with an infrared filter (not shown), and the infrared filter (not shown) may be provided to block light having a wavelength in an infrared region with respect to the light incident through the lens module **20**.

The sensor actuator **10** may be aligned with the lens module **20** in the optical axis direction (Z-axis direction). The sensor actuator **10** may be provided with the image sensor **100** to convert light incident through the lens module **20** into an electrical signal. The sensor actuator **10** may move the image sensor **100** in the optical axis direction (Z-axis direction) or in a direction (e.g., X-axis or Y-axis direction) intersecting the optical axis to perform an optical image stabilization function. For example, the sensor actuator **10** may move the image sensor **100** on a plane (X-Y plane) perpendicular to the optical axis to perform an optical image stabilization function. Alternatively, the sensor actuator **10** may rotate the image sensor **100** about the optical axis (Z-axis), or rotate about an axis (X-axis or Y-axis) perpendicular to the optical axis (Z-axis) to perform an optical image stabilization function.

The case **30** may be provided to cover the upper sides of the lens module **20** and the sensor actuator **10**. An incident hole **31** may be formed in an upper surface of the case **30**, and light incident through the incident hole **31** may be incident on the lens module **20** accommodated in the case.

Hereinafter, the sensor actuator **10**, according to one or more embodiments, will be described with reference to FIG. **2**.

FIG. **2** is an exploded perspective view of an example of a sensor actuator **10** according to one or more embodiments.

The sensor actuator **10**, according to one or more embodiments, may perform an optical image stabilization function by moving an image sensor **100** on a plane (e.g., X-Y plane) perpendicular to an optical axis to correspond to the shaking of the camera module (**1** in FIG. **1**).

The sensor actuator **10** may include an image sensor **100**, a sensor plate **110** surrounding the image sensor **100**, a first driving part **200** in which the sensor plate **110** is movably provided, a second driving part **300** in which the first driving part **200** is movably provided, and a circuit board **400** electrically connected to the image sensor **100**.

In one or more embodiments, the image sensor **100**, the first driving part **200**, the second driving part **300**, and the circuit board **400** may be provided side by side along the optical axis direction (e.g., Z-axis direction) of the lens module (e.g., **20** in FIG. **1**). For example, as illustrated in FIG. **2**, the image sensor **100** may be provided on an upper side of the first driving part **200**, the first driving part **200** may be provided on an upper side of the second driving part **300**, the second driving part **300** may be provided on an upper side of the circuit board **400**. That is, the image sensor **100**, the first driving part **200**, the second driving part **300**, and the circuit board **400** may be sequentially stacked along the optical axis direction (Z-axis direction).

The image sensor **100** may be movable with respect to the first driving part **200** in combination with the sensor plate **110**. For example, as illustrated in FIG. **2**, the sensor plate **110**, including the image sensor **100** may be movable in a direction (e.g., X-axis or Y-axis direction) perpendicular to the optical axis on an upper surface of the first driving part **200**. In the sensor actuator **10**, according to one or more embodiments, the sensor plate **110** may be provided integrally with the image sensor **100**.

The first driving part **200** may move the sensor plate **110** provided with the image sensor **100** in a direction of a first axis (e.g., X-axis) perpendicular to the optical axis (Z-axis). The first driving part **200** may include a movable plate **210** in which the image sensor **100** is movably accommodated, and one or more drivers **220** and **230** moving the image sensor **100**.

The second driving part **300** may move the first driving part **200** in a direction different from the first axis (X-axis). For example, the second driving part **300** may move the first driving part **200** in a direction of a second axis (e.g., Y-axis) perpendicular to both the optical axis (Z-axis) and the first axis (X-axis). The second driving part **300** may include a base **310** in which the movable plate **210** of the first driving part **200** is movably accommodated, and one or more drivers **320** and **330** moving the movable plate **210**. In one or more embodiments, the second driving part **300** may move the image sensor **100** together with the first driving part **200**. That is, when the first driving part **200** is moved in the direction of the second axis (Y-axis) by the second driving part **300**, the image sensor **100** accommodated in the first driving part **200** may also move together in the same direction as the first driving part **200**.

The sensor actuator **10**, according to one or more embodiments, may perform an optical image stabilization function by moving the image sensor **100** in the direction of the first axis (X-axis) or the second axis (Y-axis) perpendicular to the optical axis (Z-axis) through the first driving part **200** and the second driving part **300**.

The circuit board **400** may be provided on a lower side of the second driving part **300**. The circuit board **400** may be electrically connected to the image sensor **100** to receive image information from the image sensor **100**. In addition, the circuit board **400** may be electrically connected to one or more drivers **220** and **230** included in the first driving part **200** and one or more drivers **320** and **330** included in the second driving part **300** to apply a current or voltage or transmit a control signal to the drivers **220**, **230**, **320**, and **330**.

Hereinafter, a first driving part **200**, according to one or more embodiments, will be described with reference to FIG. **3**.

FIG. **3** is an exploded perspective view of the first driving part **200** included in the sensor actuator (**10** in FIG. **1** or **2**) according to one or more embodiments. The first driving part **200** illustrated in FIG. **3** includes the features of the first driving part (**200** in FIG. **2**) described above with reference to FIG. **2**, and thus, the description thereof will not be repeated.

The first driving part **200**, according to one or more embodiments, may move the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) provided with the image sensor (**100** in FIG. **1** or **2**) in a direction of a first axis (e.g., X-axis) perpendicular to an optical axis (Z-axis).

The first driving part **200** may include a movable plate **210** in which the sensor plate (**110** in FIG. **2**) is accommodated, and one or more drivers **220** and **230** provided in the movable plate **210** to move the sensor plate (**110** in FIG. **2**). The drivers **220** and **230** may include wires **221** and **231**, each having a length that changes when a current or voltage is applied to any one of the drivers **220** and **230**, and the image sensor (**100** in FIG. **1** or **2**) may be moved by a driving force generated according to the change in length of the wire **221** or **231**.

In one or more embodiments, the first driving part **200** may include a movable plate **210**. In the movable plate **210**, the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) provided with the image sensor (**100** in FIG. **1** or **2**) may be movably accommodated. For example, as illustrated in FIG. **3**, the movable plate **210** may include a first guide portion **240** extending in one direction (X-axis direction), and at least a portion of the sensor plate (**110** in FIG. **2**) may be inserted into the first guide portion **240** to slidably move on an upper surface of the movable plate **210** along the extending direction of the first guide portion **240**. The movable plate **210** may include one or more first guide portions **240**. For example, the movable plate **210** may include two or more first guide portions **240** provided at opposite edges of the movable plate **210**, each extending in one direction (X-axis direction).

In one or more embodiments, the movable plate **210** may be provided as a plate-shaped member having at least a partial surface perpendicular to the optical axis (Z-axis). Accordingly, the sensor plate (**110** in FIG. **2**) may move along with the movable plate **210** in a direction (e.g., X-axis direction) perpendicular to the optical axis (Z-axis). Meanwhile, the movable plate **210** is not limited to the plate shape, and may be provided in various shapes.

In one or more embodiments, the movable plate **210** may have a first hollow **250** in a portion facing the image sensor (**100** in FIG. **1** or **2**). The image sensor (**100** in FIG. **1** or **2**) accommodated on the upper surface of the movable plate **210** may be accessed through the first hollow **250** from a lower side of the movable plate **210**. For example, the circuit board included in the camera module (**1** in FIG. **1**) may be provided on a lower side of the first driving part **200**, and electrically connected to the image sensor (**100** in FIG. **1** or **2**) through the first hollow **250** of the first driving part **200**.

The first driving part **200**, according to one or more embodiments, may include one or more drivers **220** and **230**. For example, as illustrated in FIG. **3**, the first driving part **200** may include a first driver **220** and a second driver **230** provided on both sides of the sensor plate (**110** in FIG. **2**), respectively.

In one or more embodiments, each of the drivers of the first driving part **200** may be provided at a different position from the first guide portions **240** of the first driving part **200**. For example, the first driver **220** and the second driver **230** may be provided at both side edges of the movable plate **210** where the first guide portions **240** are not provided, respectively. That is, as illustrated in FIG. **3**, when the movable plate **210** has a rectangular upper surface, the first guide portions **240** may be provided on one side and the opposite side thereof, respectively, and the first driver **220** and the second driver **230** may be provided on another side adjacent to the one side and the opposite side thereof, respectively.

Any one of the drivers **220** and **230** may move or rotate the image sensor (**100** in FIG. **1** or **2**) with respect to the movable plate **210**. For example, the first driver **220** may move the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) provided with the image sensor (**100** in FIG. **1** or **2**) with respect to the movable plate **210** in the direction of the first axis (X-axis) perpendicular to the optical axis (Z-axis).

The first driver **220**, according to one or more embodiments, may include a first wire **221** a length of which changes when a voltage is applied thereto, a first lever **222** connected to the first wire **221** and rotating about a predetermined rotation axis according to the change in length of the first wire **221**, and a first lever shaft **223** forming the rotation axis of the first lever **222**.

The current or voltage may be applied to the first wire **221** from the outside of the first driving part **200**, and the first wire **221** may be provided to have a length that changes as the current or voltage is applied thereto. For example, the first wire **221** may include a shape memory alloy having a length that changes when a voltage or a current is applied thereto. In one or more embodiments, a length change amount of the first wire **221** may be proportional to a magnitude of the voltage or current applied to the first wire **221**, or may be proportional to a time period for which the voltage or current is applied to the first wire **221**.

At least a portion of the first wire **221**, according to one or more embodiments, may extend in a direction (e.g., Y-axis direction) perpendicular to the optical axis (Z-axis), and may contract in the direction (e.g., Y-axis direction) perpendicular to the optical axis (Z-axis) when a voltage is applied.

One end of the first wire **221** may be fixed to the movable plate **210** by a first fixing member **224**. In one or more embodiments, the first fixing member **224** may be formed of a conductive material, and accordingly, one end of the first wire **221** may be electrically connected to an external power source (not shown) via the first fixing member **224**.

The other end of the first wire **221** may be connected to the first lever **222**. In one or more embodiments, a first connecting member **225** binding the other end of the first wire **221** and the first lever **222** to each other may be further provided. The first connecting member **225** may be formed of a conductive material, and accordingly, the other end of the first wire **221** may be electrically connected to an external power source (not shown) via the first connecting member **225**. That is, each of one end and the other end of the first wire **221** may be electrically connected to an external power source (not shown), so that a current or voltage is applied thereto. When the voltage is applied to the first wire **221** and the length of the first wire **221** contracts, the tension of the first wire **221** may be conveyed to the first lever **222** connected to the first wire **221** accordingly.

In one or more embodiments, the first lever **222** may be rotatably supported by the first lever shaft **223** on the movable plate **210**.

The first lever **222** may be provided as a rod-shaped member with rigidity. For example, as illustrated in FIG. **3**, the first lever **222** may be provided as a rigid member continuing from a connection portion **222***a* connected to the first wire **221** to a contact portion **222***b* contacting the sensor plate (**110** in FIG. **2**). However, the shape of the first lever **222** illustrated in FIG. **3** is merely an example, and the shape of the first lever **222** may be provided in various ways.

The first lever **222** may rotate around the rotation axis formed by the first lever shaft **223**. For example, as illustrated in FIG. **3**, the first lever shaft **223** may be inserted into the movable plate **210** by penetrating through the first lever **222**, and accordingly, the first lever **222** may rotate around the first lever shaft **223** clockwise or counterclockwise. As illustrated in FIG. **3**, the first lever shaft **223** may be a separate member inserted into the first lever **222**. However, this is merely an example, and the first lever shaft **223** may be provided integrally with the first lever **222**. That is, the first lever shaft **223** may be integrally provided with the first lever **222**, and rotatably inserted into the movable plate **210**.

The first lever **222** may include a connection portion **222***a* connected to the first wire **221**. The connection portion **222***a* of the first lever **222** may be connected to the first wire **221** through the first connecting member **225**. The first connecting member **225** may be provided in the shape of a clip or clamp fitted onto the connection portion **222***a* of the first lever **222** in a state where the connection portion **222***a* of the first lever **222** and the first wire **221** are in contact with each other.

The contact portion **222***b* of the first lever **222** may be provided to contact the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) provided with the image sensor (**100** in FIG. **1** or **2**). In one or more embodiments, the contact portion **222***b* of the first lever **222** may move the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) by pushing or pulling it according to a change in length of the first wire **221**. For example, when the first wire **221** contracts and rotates the connection portion **222***a* of the first lever **222**, the contact portion **222***b* of the first lever **222** may also rotate in the same torque direction to push and move the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**).

In one or more embodiments, a portion of the first lever **222** contacting the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) may have a curved surface. For example, as illustrated in FIG. **3**, the contact portion **222***b* of the first lever **222** contacting the sensor plate (**110** in FIG. **2**) may have a curved surface. Accordingly, the curved surface of the contact portion **222***b* may smoothly press the sensor plate (**110** in FIG. **2**) while the first lever **222** rotates, or may make it possible to change the moving distance of the sensor plate (**110** in FIG. **2**) in proportion to a rotating amount of the first lever **222**.

In one or more embodiments, the first wire **221** may be connected to the first lever **222** in a state where at least a portion thereof is wound around a first roller **226**. For example, as illustrated in FIG. **3**, the first wire **221** may extend in a state where at least a portion of the first wire **221** is wound around the first roller **226** between one end thereof connected to the first fixing member **224** and the other end thereof connected to the first connecting member **225**. Accordingly, an extending direction of the first wire **221** may be changed while the first wire **221** passes through the first roller **226**.

The first roller **226** may be rotatably provided on the movable plate **210**, and a portion of the first wire **221** may be wound around the first roller **226** to be rotatable to correspond to a change in length of the first wire **221**. A rotation axis of the first roller **226** may be formed by a first roller shaft **227**. The first roller shaft **227** may be inserted into the movable plate **210** by penetrating through the first roller **226**. However, the first roller shaft **227** may be formed integrally with the first roller **226**.

In one or more embodiments, the first roller **226** may be provided adjacent to the connection portion **222***a* of the first lever **222**. Accordingly, a portion of the first wire **221** extending from the first roller **226** to the connection portion **222***a* of the first lever **222** may be substantially perpendicular to the first lever **222**. As the first wire **221** is connected to the first lever **222** perpendicularly, a tension caused by contracting a length of the first wire **221** may generate a great torque to the first lever **222**.

In one or more embodiments, the first driving part **200** may further include a second driver **230** independent from the first driver **220**. The second driver **230** may move the image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) in the direction of the first axis (X-axis) perpendicular to the optical axis (Z-axis).

In one or more embodiments, the second driver **230** may have the same structure as the first driver **220**. That is, the second driver **230** may include a second wire **231**, a length of which changes when electric power is applied thereto, a second lever **232** connected to the second wire **231** and provided to be rotatable, and a second lever shaft **233** forming a rotation axis of the second lever **232**. In addition, the second driver **230** may include a second fixing member **234** capable of fixing the second wire **231** to the movable plate **210** and a second connecting member **235** capable of binding the second lever **232** and the second wire **231** to each other. In addition, the second driver **230** may further include a second roller **236** around which at least a portion of the second wire **231** is wound, and a second roller shaft **237** forming a rotation axis of the second roller **236**. Here, the second wire **231**, the second lever **232**, the second lever shaft **233**, the second fixing member **234**, the second connecting member **235**, the second roller **236**, and the second roller shaft **237** may have the same structures as the first wire **221**, the first lever **222**, the first lever shaft **223**, the first fixing member **224**, the first connecting member **225**, the first roller **226**, and the first roller shaft **227** of the first driver **220** described above, respectively. Thus, the description of the above-mentioned components of the second driver **230** overlapping that of the first driver **220** will not be repeated, and only differences of the second driver **230** from the first driver **220** will be described below.

In one or more embodiments, the first driving part **200** may include a second driver **230** provided at a different position from the first driver **220**. For example, as illustrated in FIG. **3**, the first driving part **200** may include a first driver **220** and a second driver **230** on both sides of the sensor plate (**110** in FIG. **2**), respectively. In one or more embodiments, the second wire **231** of the second driver **230** and the first wire **221** of the first driver **220** may be provided at opposite edges of the movable plate **210**, respectively, and may extend in a direction to be parallel to each other.

As the first driver **220** and the second driver **230** are provided at different positions, driving directions of the first driver **220** and the second driver **230** may also be different from each other.

In one or more embodiments, the second driver **230** and the first driver **220** may move the image sensor (**100** in FIG. **1** or **2**) in opposite directions. For example, the first driver **220** may move the image sensor (**100** in FIG. **1** or **2**) in a positive direction of the first axis (X-axis), and the second driver **230** may move the image sensor (**100** in FIG. **1** or **2**) in a negative direction of the first axis (X-axis). That is, the image sensor (**100** in FIG. **1** or **2**) may be moved in both the positive direction and the negative direction of the first axis (X-axis) by the first driver **220** and the second driver **230**.

In one or more embodiments, rotating directions of the first lever **222** and the second lever **232** according to the contraction of the first wire **221** and the second wire **231** may be opposite to each other. For example, as the first wire **221** contracts, the first lever **222** rotates counterclockwise to move the image sensor (**100** in FIG. **1** or **2**) in the positive direction of the first axis (X-axis). On the other hand, as the second wire **231** contracts, the second lever **232** rotates clockwise to move the image sensor (**100** in FIG. **1** or **2**) in the negative direction of the first axis (X-axis). That is, the image sensor (**100** in FIG. **1** or **2**) may be moved in either the positive direction or the negative direction of the first axis (X-axis) by contracting any one of the first wire **221** and the second wire **231**.

In one or more embodiments, the first driver **220** and the second driver **230** may be controlled independently of each other. For example, only one of the first driver **220** and the second driver **230** may be driven, or both the first driver **220** and the second driver **230** may be driven sequentially. In this way, the first driving part **200** may perform an optical image stabilization function by appropriately moving the image sensor (**100** in FIG. **1** or **2**) in a direction (e.g., X-axis direction) perpendicular to the optical axis (Z-axis).

In one or more embodiments, the sensor actuator (**10** in FIG. **1** or **2**) may further include a second driving part (**300** in FIG. **2**) capable of moving the image sensor (**100** in FIG. **1** or **2**) in a different direction (e.g., Y-axis direction) from the first driving part **200**.

Hereinafter, a second driving part **300** will be described with reference to FIG. **4**.

FIG. **4** is an exploded perspective view of an example of a second driving part **300** included in the sensor actuator (**10** in FIG. **1** or **2**) according to one or more embodiments. A first driving part illustrated in FIG. **4** corresponds to the first driving part (**200** in FIG. **3**) described above with reference to FIG. **3**. Thus, for the first driving part to be described below, the description of the first driving part (**200** in FIG. **3**) provided above with reference to FIG. **3** may be referred to.

The second driving part **300**, according to one or more embodiments, may move the first driving part (**200** in FIG. **3**) in a direction (e.g., Y-axis direction) perpendicular to the optical axis (Z-axis). For example, the second driving part **300** may move the first driving part (**200** in FIG. **3**) in the direction of a second axis (Y-axis) perpendicular to both the optical axis (Z-axis) and the first axis (X-axis) perpendicular to the optical axis (Z-axis). As the first driving part (**200** in FIG. **3**) is moved in the direction of the second axis (Y-axis) by the second driving part **300**, the image sensor (**100** in FIG. **1** or **2**) accommodated in the first driving part (**200** in FIG. **3**) may also be moved in the direction of the second axis (Y-axis) together with the first driving part (**200** in FIG. **3**). That is, the second driving part **300** may move the first driving part (**200** in FIG. **3**) and the image sensor (**100** in FIG. **1** or **2**) together in the direction of the second axis (Y-axis).

The second driving part **300**, according to one or more embodiments, may include a base **310** in which the movable plate (**210** in FIG. **3**) of the first driving part (**200** in FIG. **3**) is accommodated, and one or more drivers **320** and **330** provided on the base **310** to move the movable plate (**210** in FIG. **3**). The drivers **320** and **330** may include wires **321** and **331**, each having a length that changes when a current or voltage is applied to any one of the drivers **320** and **330**, and the movable plate (**210** in FIG. **3**) may be moved by a driving force generated according to the change in length of the wire **321** or **331**.

In one or more embodiments, the second driving part **300** may include a base **310**. The image sensor (**100** in FIG. **1** or **2**) or the sensor plate (**110** in FIG. **2**) provided with the image sensor (**100** in FIG. **1** or **2**), and the first driving part (**200** in FIG. **3**) may be movably accommodated in the base **310**. For example, as illustrated in FIG. **4**, the base **310** may include a second guide portion **340** extending in one direction (Y-axis direction), and at least a portion of the movable plate (**210** in FIG. **3**) may be inserted into the second guide portion **340** to slidably move on an upper surface of the base **310** along the extending direction of the second guide portion **340**. The base **310** may include one or more second guide portions **340**. For example, the base **310** may include two or more second guide portions **340** provided at opposite edges of the base **310**, each extending in one direction (Y-axis direction).

In one or more embodiments, the direction in which the second guide portions **340** extend may be perpendicular to the direction in which the first guide portions (**240** in FIG. **3**) extend. For example, the first guide portions (**240** in FIG. **3**) may extend in the direction of the first axis (X-axis) perpendicular to the optical axis (Z-axis), and the second guide portions **340** may extend in the direction of the second axis (Y-axis) perpendicular to both the optical axis (Z-axis) and the first axis (X-axis). Since the first guide portions (**240** in FIG. **3**) and the second guide portions **340** extend in directions perpendicular to each other, respectively, the sensor plate (**110** in FIG. **2**) and the movable plate (**210** in FIG. **3**) may move in directions perpendicular to each other along the first guide portions (**240** in FIG. **3**) and the second guide portions **340**, respectively.

In one or more embodiments, the base **310** may be provided as a plate-shaped member having at least a partial surface perpendicular to the optical axis (Z-axis). Accordingly, the movable plate (**210** in FIG. **3**) may move along with the base **310** in a direction perpendicular to the optical axis (Z-axis) direction. Meanwhile, the base **310** is not limited to the plate shape, and may be provided in various shapes.

In one or more embodiments, the base **310** may have a second hollow **350** in a portion facing the image sensor (**100** in FIG. **1** or **2**). The second hollow **350** of the base **310** and the first hollow (**250** in FIG. **3**) of the movable plate (**210** in FIG. **3**) may communicate with each other. Accordingly, the image sensor (**100** in FIG. **1** or **2**) accommodated on the upper surface of the movable plate (**210** in FIG. **3**) may be accessed through the first hollow (**250** in FIG. **3**) and the second hollow **350** from a lower side of the base **310**. For example, the circuit board (**400** in FIG. **1** or **2**) included in the sensor actuator (**10** in FIG. **1** or **2**) may be provided on a lower side of the second driving part **300**, and electrically connected to the image sensor (**100** in FIG. **1** or **2**) through the first hollow (**250** in FIG. **3**) of the first driving part (**200** in FIG. **3**) and the second hollow **350** of the second driving part **300**.

The second driving part **300**, according to one or more embodiments, may include one or more drivers **320** and **330**. For example, as illustrated in FIG. **4**, the second driving part **300** may include a third driver **320** and a fourth driver **330** provided on both sides of the base **310**, respectively.

In one or more embodiments, any one of the drivers **320** and **330** included in the second driving part **300** may move or rotate the first driving part (**200** in FIG. **3**) with respect to the base **310**. For example, the third driver **320** may move the first driving part (**200** in FIG. **3**) and the image sensor (**100** in FIG. **1** or **2**) together with respect to the base **310** in the direction of the first axis (X-axis) perpendicular to the optical axis (Z-axis). That is, the movable plate (**210** in FIG. **3**) and the first and second drivers included in the first driving part (**200** in FIG. **3**), and the image sensor (**100** in FIG. **1** or **2**) accommodated in the movable plate (**210** in FIG. **3**) may be moved together in the direction of the first axis (X-axis) through a driving force generated by the third driver **320**.

In one or more embodiments, any one of the drivers **320** and **330** included in the second driving part **300** may have the same structure as the first driver (**220** in FIG. **3**) described above with reference to FIG. **3**. For example, the third driver **320** and the fourth driver **330** of the second driving part **300** may have the same structure as the first driver (**220** in FIG. **3**). That is, the third driver **320**, according to one or more embodiments, may include a third wire **321** a length of which changes when a voltage is applied thereto, a third lever **322** connected to the third wire **321** and rotating about a predetermined rotation axis according to the change in length of the third wire **321**, and a third lever shaft **323** forming a rotation axis of the third lever **322**. In addition, the third lever **322** of the third driver **320** may include a connection portion **322***a* and a contact portion **322***b*, and a third connecting member **325** may be coupled to the connection portion **322***a* of the third lever **322**. The third wire **321** may be fixed to the base **310** by a third fixing member **324**. The third driver **320** may further include a third roller **326** around which at least a portion of the third wire **321** is wound, and a third roller shaft **327** forming a rotation axis of the third roller **326**.

Similarly, the fourth driver **330**, according to one or more embodiments, may include a fourth wire **331** a length of which changes when a voltage is applied thereto, a fourth lever **332** connected to the fourth wire **331** and rotating about a predetermined rotation axis according to the change in length of the fourth wire **331**, and a fourth lever shaft **333** forming a rotation axis of the fourth lever **332**. In addition, a fourth connecting member **335** binding the fourth wire **331** and the fourth lever **332** of the fourth driver **330** to each other may be provided. The fourth wire **331** may be fixed to the base **310** by a fourth fixing member **334**. The fourth driver **330** may further include a fourth roller **336** around which at least a portion of the fourth wire **331** is wound, and a fourth roller shaft **337** forming a rotation axis of the fourth roller **336**.

Hereinafter, the description of the above-mentioned components of the third and fourth drivers **320** and **330** overlapping that of the first driver (**220** in FIG. **3**) will not be repeated, and only differences of the third and fourth drivers **320** and **330** from the first driver (**220** in FIG. **3**) will be described.

At least one of the drivers **320** and **330** included in the second driving part **300**, according to one or more embodiments, may be provided on the base **310**. For example, as illustrated in FIG. **4**, the third driver **320** and the fourth driver **330** may be provided at opposite edges of the base **310**, respectively.

In one or more embodiments, each of the drivers **320** and **330** of the second driving part **300** may be provided at a different position from the second guide portions **340** of the second driving part **300**. For example, the third driver **320** and the fourth driver **330** may be provided at the edges of the base **310** where the second guide portions **340** are not provided. As illustrated in FIG. **4**, when the base **310** has a rectangular upper surface, the second guide portions **340** may be provided on one side and the opposite side thereof, respectively, and the third driver **320** and the fourth driver **330** may be provided on another side adjacent to the one side and the opposite side thereof, respectively.

In one or more embodiments, the third driver **320** and the fourth driver **330** of the second driving part **300** may be provided adjacent to the first guide portions (**240** in FIG. **3**), respectively. Accordingly, the third driver **320** and the fourth driver **330** may push or pull portions where the first guide portions (**240** in FIG. **3**) are formed of the first driving part (**200** in FIG. **3**), respectively, to move the first driving part (**200** in FIG. **3**).

In one or more embodiments, the driving directions of the third driver **320** and the fourth driver **330** may be different from each other. In other words, the third driver **320** and the fourth driver **330** may move the image sensor (**100** in FIG. **1** or **2**) or the first driving part (**200** in FIG. **3**) in opposite directions. For example, the third driver **320** may push the image sensor (**100** in FIG. **1** or **2**) for movement in a positive direction of the second axis (Y-axis), and the fourth driver **330** may push the image sensor (**100** in FIG. **1** or **2**) for movement in a negative direction of the second axis (Y-axis). That is, the first driving part (**200** in FIG. **3**) and the image sensor (**100** in FIG. **1** or **2**) accommodated in the first driving part (**200** in FIG. **3**) may be moved in both the positive direction and the negative direction of the second axis (Y-axis) by the third driver **320** and the fourth driver **330**.

In one or more embodiments, the third driver **320** and the fourth driver **330** may be provided at positions intersecting the first driver (**220** in FIG. **3**) and the second driver (**230** in FIG. **3**) of the first driving part (**200** in FIG. **3**), respectively, with the image sensor (**100** in FIG. **1** or **2**) positioned at the center. For example, when the sensor actuator (**10** in FIG. **1** or **2**) is viewed from above, the first driver (**220** in FIG. **3**), the second driver (**230** in FIG. **3**), the third driver **320**, and the fourth driver **330** may be provided adjacent to the four sides of the image sensor (**100** in FIG. **1** or **2**), respectively.

Hereinafter, a structure of a sensor actuator **10**, including first to fourth drivers **220**, **230**, **320**, and **330** according to one or more embodiments, will be described with reference to FIGS. **5** to **7**.

FIG. **5** is a perspective view of the sensor actuator **10** according to one or more embodiments, FIG. **6** is a cross-sectional view taken along line A-A' of FIG. **5**, and FIG. **7** is a cross-sectional view taken along line B-B' of FIG. **5**.

The sensor actuator **10** and its components to be described below with reference to FIGS. **5** to **7** include the features of the sensor actuator **10** and its components described above with reference to FIGS. **1** to **4**, and thus, the description thereof will not be repeated.

The sensor actuator **10**, according to one or more embodiments, may include an image sensor **100** converting light incident in an optical axis direction (e.g., Z-axis direction) into an electrical signal, and one or more drivers **220**, **230**, **320**, **330** capable of moving the image sensor **100**.

The image sensor **100** may be accommodated in a sensor plate **110** having a hollow. The sensor plate **110** may be formed as a plate-shaped member having a hollow, and incident light may be incident on the image sensor **100** accommodated in the sensor plate **110** through the hollow. Meanwhile, the sensor plate **110** is not limited to the plate shape, and may be provided in various shapes. Alternatively, the sensor plate **110** may be integrally formed with the image sensor **100**.

The sensor plate **110** provided with the image sensor **100** may be movably accommodated in the movable plate **210** of the first driving part (**200** in FIG. **2** or **3**). For example, as illustrated in FIG. **5**, the sensor plate **110** provided with the image sensor **100** may be accommodated in the movable plate **210** to be movable in a direction (e.g., X-axis direction) perpendicular to the optical axis (Z-axis) along an upper surface of the movable plate **210**.

The movable plate **210** may be movably accommodated in the base **310** of the second driving part (**300** in FIG. **2** or **4**). For example, as illustrated in FIG. **5**, the movable plate **210** may be accommodated in the base **310** to be movable in a direction (e.g., Y-axis direction) perpendicular to the optical axis (Z-axis) along an upper surface of the base **310**.

In one or more embodiments, the sensor plate **110**, the movable plate **210**, and the base **310** may be stacked in the optical axis direction (Z-axis direction). In addition, a circuit board (e.g., **400** in FIG. **1** or **2**) electrically connected to the image sensor **100** or one or more drivers **220**, **230**, **320**, and **330** may be further provided at a lower end of the base **310**.

In one or more embodiments, a direction in which the sensor plate **110** is movable with respect to the movable plate **210** and a direction in which the movable plate **210** is movable with respect to the base **310** may intersect with each other. For example, as illustrated in FIG. **5**, the sensor plate **110** may be movable with respect to the movable plate **210** in the direction of a first axis (X-axis) perpendicular to the optical axis (Z-axis), and the movable plate **210** may be movable with respect to the base **310** in the direction of a second axis (Y-axis) perpendicular to both the optical axis (Z-axis) and the first axis (X-axis). Accordingly, the image sensor **100** accommodated in the sensor plate **110** may be movable in both directions of the first axis (X-axis) and the second axis (Y-axis).

In one or more embodiments, the sensor actuator **10** may include one or more drivers **220**, **230**, **320**, and **330** capable of moving the image sensor **100** in a direction of a plane (X-Y plane) perpendicular to the optical axis (Z-axis). For example, as illustrated in FIG. **5**, the sensor actuator **10** may include a first driver **220** and a second driver **230**, moving the image sensor **100** in the direction of the first axis (X-axis) perpendicular to the optical axis (Z-axis). In addition, the sensor actuator **10** may include a third driver **320** and a fourth driver **330**, moving the image sensor **100** in the direction of the second axis (Y-axis) perpendicular to both the optical axis (Z-axis) and the first axis (X-axis).

In one or more embodiments, the plurality of drivers **220**, **230**, **320**, and **330** included in the sensor actuator **10** may be provided at different positions. For example, as illustrated in FIG. **5**, the four drivers **220**, **230**, **320**, and **330** may be provided adjacent to the four sides of the image sensor **100**, respectively.

In one or more embodiments, the plurality of drivers **220**, **230**, **320**, and **330** included in the sensor actuator **10** may be provided on different layers of the sensor actuator **10**. For example, as illustrated in FIG. **5**, the first and second drivers **220** and **230** may be provided on the movable plate **210**, and the third and fourth drivers **320** and **330** may be provided on the base **310**, which is positioned on a lower side of the movable plate **210**.

In one or more embodiments, the drivers **220**, **230**, **320**, and **330** provided on the different layers of the sensor actuator **10** may be provided to move different components of the sensor actuator **10**. For example, the plurality of drivers **220**, **230**, **320**, and **330** may move different plates **110** and **210**. That is, as illustrated in FIG. **5**, the first driver **220** provided on the movable plate **210** may be provided to move the sensor plate **110**, and the third driver **320** provided on the base **310** may be provided to move the movable plate **210**. In one or more embodiments, when the movable plate **210** is moved by the third driver **320**, the sensor plate **110** and the one or more drivers **220** and **230** may also move together with the movable plate **210**. That is, one or more drivers **320** and **330** provided on the base **310** of the second driving part (**300** in FIG. **4**) may move the image sensor **100**, the sensor plate **110**, and the first driving part (**200** in FIG. **3**).

Each of the drivers **220**, **230**, **320**, and **330** according to one or more embodiments may include a wire, a length of which changes when a current or voltage is applied thereto, and the wires included in the plurality of drivers **220**, **230**, **320**, and **330** may be provided on different layers of the sensor actuator **10**. For example, as illustrated in FIG. **5**, a first wire **221** included in the first driver **220** may be provided on the movable plate **210**, and a fourth wire **331** included in the fourth driver **330** may be provided on the base **310**, which is positioned on the lower side of the movable plate **210**.

Each of the plurality of wires included in the drivers **220**, **230**, **320**, and **330**, according to one or more embodiments, may move the image sensor in a direction different from a direction in which the length of the wire extends. For example, at least a portion of the first wire **221** of the first driver **220** may extend in the direction of the second axis (Y-axis), and the image sensor **100** may be moved in the direction of the first axis (X-axis) perpendicular to the second axis (Y-axis) according to the change in length of the first wire **221**. In addition, at least a portion of the fourth wire **331** of the fourth driver **330** may extend in the direction of the first axis (X-axis), and the image sensor **100** may be moved in the direction of the second axis (Y-axis) perpendicular to the first axis (X-axis) according to the change in length of the fourth wire **331**. Accordingly, according to one or more embodiments, the plurality of wires may be integratedly disposed in a small space of the sensor actuator **10** to move the image sensor in various directions.

The drivers **220**, **230**, **320**, and **330**, according to one or more embodiments, may be electrically connected to the circuit board (**400** in FIG. **1** or **2**) to receive a current or voltage from an external power source. For example, as illustrated in FIG. **5**, one end and the other end of the first wire **221** included in the first driver **220** may be connected to cables **228** and **229**, respectively, to be electrically connected to the circuit board (**400** in FIG. **1** or **2**) and the external power source (not shown). In a case in which a first fixing member **224** and a first connecting member **225** are formed of a conductive material, the cables **228** and **229** may be connected to the first fixing member **224** and the first connecting member **225**, respectively, to be electrically connected to the first wire **221**. Accordingly, a closed circuit may be configured to pass through the first wire **221** from the external power source (not shown), so that a voltage or current flows through the first wire **221**. However, the connection structure between the first wire **221** and the external power source (not shown) is not limited to what has been described above. For example, at least one of the cables **228** and **229** connected to one end and the other end of the first wire **221**, respectively, may be omitted. As illustrated in FIG. **5**, one end of the fourth wire **331** may be connected to a fourth fixing member **334**, and the fourth fixing member **334** may be electrically connected to the circuit board (**400** in FIG. **1** or **2**) in a direct manner. Accordingly, one end of the fourth wire **331** may be electrically connected to the circuit board (**400** in FIG. **1** or **2**) without a cable. Alternatively, the other end of the fourth wire **331** may be connected to the circuit board (**400** in FIG. **1** or **2**) through a cable **338**.

The sensor plate **110** may be accommodated in the movable plate **210**, and move in a direction (e.g., X-axis direction) perpendicular to the optical axis (Z-axis). In one or more embodiments, the movable plate **210** may have first guide portions **240** guiding the movement of the sensor plate **110**. The first guide portion **240**, according to one or more embodiments, may include a first extension portion **241** extending from the movable plate **210** in the direction of the optical axis (Z-axis), and a first bent portion **242** bent from the first extension portion **241** in a direction (e.g., Y-axis direction) intersecting the optical axis (Z-axis). The first extension portion **241** and the first bent portion **242** may be formed to be approximately perpendicular to each other, and the first bent portion **242** and the movable plate **210** may be formed to be approximately parallel to each other. That is, the first guide portion **240** may be formed to extend from the movable plate **210** in the direction of a first axis (e.g., X-axis) perpendicular to the optical axis (Z-axis), while having a '¬'-shaped cross section.

In one or more embodiments, the image sensor **100** or the sensor plate **110** provided with the image sensor **100** may be at least partially inserted between the first bent portion **242** and the movable plate **210** to slidably move in the direction of the first axis (X-axis) in which the first guide portion **240** extends. Alternatively, in one or more embodiments, the first guide portion **240** may have a first guide groove surrounded by the movable plate **210**, the first extension portion **241**, and the first bent portion **242**, and the sensor plate **110** may be at least partially inserted into the first guide groove to slidably move in the direction of the first axis (X-axis).

In one or more embodiments, the first guide portions **240** may be provided at opposite edges of the movable plate **210**, respectively. In this case, the first bent portions **242** included in the respective first guide portions **240** may be bent from the first extension portions **241** in directions to face each other.

In order to reduce friction between the sensor plate **110** and the movable plate **210**, one or more friction-reducing members **112** may be provided at portions where the sensor plate **110** and the movable plate **210** abut on each other. In one or more embodiments, one or more friction-reducing members **112** may be provided on at least portions of the sensor plate **110** inserted between the first bent portion **242** and the movable plate **210**. For example, as illustrated in FIG. **6**, the sensor plate **110** may include a first insertion portion **111** inserted into the first guide portion **240** of the movable plate **210**, and the friction-reducing members **112** may be provided on the first insertion portion **111**. The friction reducing member **112** may be a protrusion-shaped member reducing a contact area between the sensor plate **110** and the movable plate **210**. When provided in the protrusion shape, the friction-reducing members **112** may be provided to protrude upward and downward of the first insertion portion **111**, respectively. Alternatively, the friction-reducing members **112** may be provided to protrude from the ends of the first insertion portion **111**, respectively, in a direction perpendicular to the optical axis. In one or more embodiments, the friction-reducing members **112** may be integrally formed with the sensor plate **110**. However, the friction-reducing member **112** is not limited thereto, and may be configured as, for example, a bush, a linear bearing, or a ball bearing. Alternatively, the friction-reducing member **112** may be provided on the first guide portion **240** of the movable plate **210**.

In one or more embodiments, the sensor plate **110** may contact the movable plate **210** via the friction reducing member **112**. That is, a portion of the sensor plate **110** other than the friction reducing member **112** may be spaced apart from the movable plate **210** at a predetermined interval. Accordingly, it is possible to form a very small friction force between the sensor plate **110** and the movable plate **210**.

In one or more embodiments, a lubricating material reducing friction may be applied between the friction reducing member **112** and the first guide portion **240** or the movable plate **210**.

In one or more embodiments, the movable plate **210** may be accommodated in the base **310** to move in a direction (e.g., Y-axis direction) perpendicular to the optical axis (Z-axis). In one or more embodiments, the base **310** may have second guide portions **340** guiding the movement of the movable plate **210**. The second guide portion **340**, according to one or more embodiments, may include a second extension portion **341** extending from the base **310** in the direction of the optical axis (Z-axis), and a second bent portion **342** bent from the second extension portion **341** in a direction (e.g., X-axis direction) intersecting the optical axis (Z-axis). The second extension portion **341** and the second bent portion **342** may be formed to be approximately perpendicular to each other, and the second bent portion **342** and the base **310** may be formed to be approximately parallel to each other. That is, second guide portion **340** may be formed to extend from the base **310** in the direction of a second axis (e.g., Y-axis) perpendicular to the optical axis (Z-axis), while having a '¬'-shaped cross section.

In one or more embodiments, at least a portion of the movable plate **210** may be inserted between the second bent portion **342** and the base **310** to slidably move in the direction of the second axis (Y-axis) in which the second guide portion **340** extends. Alternatively, in one or more embodiments, the second guide portion **340** may have a second guide groove surrounded by the base **310**, the second extension portion **341**, and the second bent portion **342**, and the movable plate **210** may be at least partially inserted into the second guide groove to slidably move in the direction of the second axis (Y-axis).

In one or more embodiments, the second guide portions **340** may be provided at opposite edges of the base **310**, respectively. In this case, the second bent portions **342** included in the respective second guide portions **340** may be bent from the second extension portions **341** in directions to face each other.

In order to reduce friction between the movable plate **210** and the base **310**, one or more friction-reducing members

212 may be further provided at portions where the movable plate 210 and the base 310 abut on each other. In one or more embodiments, one or more friction-reducing members 212 may be provided on at least portions of the movable plate 210 inserted between the second bent portion 342 and the base 310. For example, as illustrated in FIG. 7, the movable plate 210 may include a second insertion portion 211 inserted into the second guide portion 340 of the base 310, and the friction-reducing members 212 may be provided on the second insertion portion 211. Alternatively, the friction-reducing members 212 may be provided on the second guide portion 340 of the base 310. The friction reducing member 212 provided between the movable plate 210 and the base 310 may have the same structure as the above-described friction reducing member 112 provided between the sensor plate 110 and the movable plate 210. For example, the friction-reducing member 212 may be provided on the second insertion portion 211, and may be a protrusion-shaped member provided to reduce a contact area between the movable plate 210 and the base 310.

In one or more embodiments, the movable plate 210 may contact the base 310 via the friction-reducing member 212. That is, a portion of the movable plate 210 other than the friction reducing member 212 may be spaced apart from the base 310 at a predetermined interval. Accordingly, it is possible to form a very small friction force between the movable plate 210 and the base 310.

In one or more embodiments, a lubricating material reducing friction may be applied between the friction reducing member 212 and the second guide portion 340 or the base 310.

Hereinafter, the driving of a driver (e.g., 220, 230, 320, or 330 in FIG. 5) according to one or more embodiments will be described with reference to FIGS. 8A and 8B.

FIGS. 8A and 8B are reference views for explaining the driving of the driver (e.g., 220, 230, 320, or 330 in FIG. 5) included in the sensor actuator (e.g., 10 in FIG. 5) according to the one or more embodiments. The driver 320 to be described below with reference to FIGS. 8A and 8B corresponds to any one of the drivers 220, 230, 320, and 330 described above with reference to FIGS. 3 to 5, and thus, the overlapping description thereof will not be repeated. In addition, although only one driver (e.g., third driver) is described with reference to FIGS. 8A and 8B, the same may be applied to the other drivers (e.g., first, second, and fourth drivers) included in the sensor actuator. That is, the driver 320 to be described below may correspond to any one of the first to fourth drivers 220, 230, 320, and 330 described above with reference to FIGS. 3 to 5.

The driver 320, according to one or more embodiments, may include a wire 321 a length of which changes according to a control signal, a lever 322 connected to the wire 321 and rotating according to the change in length of the wire 321, and a lever shaft 323 forming a rotation axis of the lever 322.

The wire 321 may be electrically connected to an external power source (not shown) through a cable 328 to receive a current or voltage. At least a portion of the wire 321 may be fixed by a fixing member 324, and another portion of the wire 321 may be connected to the lever 322 by a connecting member 325 to be movable. Accordingly, when the length of the wire 321 contracts, the wire 321 may pull the lever 322 connected thereto through the connecting member 325, so that the lever 322 rotates.

The lever 322 may include a connection portion 322*a* connected to the wire 321 and a contact portion 322*b* contacting the movable plate 210 or the sensor plate 110. The connection portion 322*a* of the lever 322 may move together with the wire 321 according to the change in length of the wire 321, and the contact portion 322*b* may move the image sensor 100 in a predetermined direction (e.g., Y-axis direction) according to the rotation of the lever 322.

In one or more embodiments, the rotation axis of the lever 322 may be provided between the connection portion 322*a* and the contact portion 322*b*. In this case, a distance from the connection portion 322*a* to the rotation axis may differ from the distance from the contact portion 322*b* to the rotation axis. For example, when the distance from the rotation axis formed by the lever shaft 323 to the connection portion 322*a* is referred to as a first distance C1, and the distance from the rotation axis to the contact portion 322*b* is referred to as a second distance C2, the first distance C1 may be smaller than the second distance C2 as illustrated in FIG. 8A. Since the first distance C1 is smaller than the second distance C2, when the lever 322 rotates, an arc trajectory drawn by the connection portion 322*a* may be shorter than that drawn by the contact portion 322*b*.

In addition, since the second distance C2 is larger than the first distance C1, a moving distance of the contact portion 322*b* rotating according to the change in length of the wire 321 may be greater than an amount of the change in length of the wire 321. Thus, a moving distance of the image sensor 100 moved by the contact portion 322*b* of the lever 322 may be relatively larger than the amount of the change in length of the wire 321. For example, in a case in which a predetermined voltage is applied to the wire 321, when the amount of the change in length of the wire 321 is referred to as a third distance d1, and the moving distance of the image sensor 100 according to the change in length of the wire 321 is referred to as a fourth distance d2, the fourth distance d2 may be larger than the third distance d1. That is, in the sensor actuator (10 in FIG. 1, 2, or 5) according to one or more embodiments, through the structure of the lever 322 in which the first distance C1 and the second distance C2 are different from each other, the moving distance of the image sensor 100 may have a larger value than the amount of the change in length of the wire 321. Accordingly, even if the amount of the change in length of the wire 321 is small, it is possible to secure a sufficient movement stroke of the image sensor 100. In this way, the sensor actuator (10 in FIG. 1, 2, or 5), according to one or more embodiments, may more effectively perform an optical image stabilization function using the movement of the image sensor 100.

The sensor actuator (10 in FIG. 1, 2, or 5), according to one or more embodiments, may include a plurality of drivers 220, 230, 320, and 330 moving the image sensor 100 in different directions. Hereinafter, the driving of the plurality of drivers 220, 230, 320, and 330 will be described with reference to FIGS. 9A to 9F.

FIGS. 9A to 9F are reference views for explaining the driving of a sensor actuator 10 according to one or more embodiments. The sensor actuator 10 to be described below with reference to FIGS. 9A to 9F includes all the features of the sensor actuator 10 described above with reference to FIGS. 1 to 8, and thus, the overlapping description thereof will not be repeated.

The sensor actuator 10, according to one or more embodiments, may include a plurality of drivers 220, 230, 320, and 330 receiving electrical energy from an external power source (not shown) to move an image sensor 100. For example, as illustrated in FIG. 9A, the sensor actuator 10 may include first and second drivers 220 and 230 capable of moving the image sensor 100 in the direction of a first axis (X-axis) perpendicular to an optical axis (Z-axis), and may include third and fourth drivers 320 and 330 capable of moving the image sensor **100** in the direction of a second axis (Y-axis) perpendicular to the first axis (X-axis).

The first driver **220** and the second driver **230** may move a sensor plate **110** provided with the image sensor **100**. For example, as illustrated in FIGS. **9**A and **9**B, the first driver **220** or the second driver **230** may move the sensor plate **110** in the direction of the first axis (X-axis). The first driver **220** and the second driver **230** may be provided on the movable plate **210**, and may be controlled independently of each other. For example, one of the first driver **220** and the second driver **230** may be driven, and the other one may not be driven. As the first driver **220** is driven, the image sensor **100** may move in a positive direction of the first axis (X-axis), and as the second driver **230** is driven, the image sensor **100** may move in a negative direction of the first axis (X-axis). In one or more embodiments, the first driver **220** and the second driver **230** may be driven simultaneously or sequentially. For example, the first driver **220** and the second driver **230** may receive currents or voltages of different magnitudes simultaneously or sequentially to precisely move the image sensor **100** to a desired position on the first axis (X-axis).

In one or more embodiments, the third driver **320** and the fourth driver **330** may be provided to move the movable plate **210** in which the image sensor **100** is accommodated. As the movable plate **210** is moved in the direction of the second axis (Y-axis) by the third driver **320** and the fourth driver **330**, the image sensor **100** may also move together with the movable plate **210**. For example, as illustrated in FIGS. **9**C and **9**D, the third driver **320** and the fourth driver **330** may move the movable plate **210** in the direction of the second axis (Y-axis). As the movable plate **210** moves, the first driver **220**, the second driver **230**, and the sensor plate **110** provided on the movable plate **210** may also move together. The third driver **320** and the fourth driver **330** may be provided on the base **310**, and may be controlled independently of each other. For example, one of the third driver **320** and the fourth driver **330** may be driven, and the other one may not be driven. As the third driver **320** is driven, the movable plate **210** and the image sensor **100** may move in a positive direction of the second axis (Y-axis), and as the fourth driver **330** is driven, the movable plate **210** and the image sensor **100** may move in a negative direction of the second axis (Y-axis). In one or more embodiments, the third driver **320** and the fourth driver **330** may be driven simultaneously or sequentially. For example, the third driver **320** and the fourth driver **330** may receive currents or voltages of different magnitudes simultaneously or sequentially to precisely move the image sensor **100** to a desired position on the second axis (Y-axis).

In one or more embodiments, at least some of the first to the fourth drivers **220**, **230**, **320**, and **330** may be driven simultaneously or sequentially. Accordingly, the image sensor **100** may move in various directions on a plane (X-Y plane) perpendicular to the optical axis (Z-axis). For example, as illustrated in FIG. **9**E, the first driver **220** and the third driver **320** may be driven simultaneously. That is, the third driver **320** may move the movable plate **210** in the positive direction of the second axis (Y-axis), and at the same time, the first driver **220** may move the sensor plate **110** in the positive direction of the first axis (X-axis). Accordingly, the image sensor **100** may quickly move in a diagonal direction between the positive direction of the first axis (X-axis) and the positive direction of the second axis (Y-axis) to perform an optical image stabilization function. Alternatively, as illustrated in FIG. **9**F, the second driver **230** and the fourth driver **330** may be driven simultaneously, so that the image sensor **100** is quickly moved in a diagonal direction between the negative direction of the first axis and the negative direction of the second axis (Y-axis) to perform an optical image stabilization function.

In the sensor actuator **10**, according to one or more embodiments, the plurality of drivers **220**, **230**, **320**, and **330** moving the image sensor **100** in different directions may be provided on different layers. For example, the third driver **320** and the fourth driver **330** may be provided on the base **310**, and the first driver **220** and the second driver **230** may be provided on the movable plate **210**, which is positioned on an upper side of the base **310**. Accordingly, even though the movable plate **210** is moved by the third driver **320** or the fourth driver **330**, the first driver **220** and the second driver **230** may maintain the same positions with respect to the movable plate **210** and the image sensor **100**. That is, relative positions between the first and second drivers **220** and **230** and the image sensor **100** may remain unchanged. Accordingly, the first driver **220** and the second driver **230** may precisely move the image sensor **100** regardless of whether the third driver **320** or the fourth driver **330** is driven, thereby accurately performing an optical image stabilization function.

As set forth above, the sensor actuator and the camera module, including the same according to one or more embodiments, can move the image sensor in a direction intersecting the optical axis to implement an optical image stabilization function.

Since the sensor actuator and the camera module, including the same according to one or more embodiments, can move the image sensor using a wire, a length of which changes, it is possible to provide a sensor actuator and a camera module having high operational reliability with a simple structure.

Since the sensor actuator and the camera module, including the same according to one or more embodiments, can move the image sensor using a wire, a length of which changes, it is possible to reduce the power consumption desired for moving the image sensor.

The sensor actuator and the camera module, including the same according to one or more embodiments, can move the image sensor in a direction intersecting the optical axis using a very small amount of a change in length of the wire.

Since the sensor actuator and the camera module, including the same according to one or more embodiments, can move the image sensor using a wire, a length of which changes, it is possible to minimize electromagnetic interference in another electronic component.

The sensor actuator and the camera module, including the same according to one or more embodiments, are capable of precisely and quickly moving the image sensor by adjusting the speed and an amount of the change in length of the wire.

The present disclosure may solve at least some of the aforementioned problems of the related art, and an object of the present disclosure is to provide a sensor actuator capable of moving an image sensor to implement an autofocusing function, an optical image stabilization function, or the like with a simple structure, while reducing power consumption, or a camera module including the same.

While this disclosure includes specific examples, it will be apparent after an understanding of the disclosure of this application that various changes in form and details may be made in these examples without departing from the spirit and scope of the claims and their equivalents. The examples described herein are to be considered in a descriptive sense only, and not for purposes of limitation. Descriptions of features or aspects in each example are to be considered as being applicable to similar features or aspects in other examples. Suitable results may be achieved if the described techniques are performed in a different order, and/or if components in a described system, architecture, device, or circuit are combined in a different manner, and/or replaced or supplemented by other components or their equivalents. Therefore, the scope of the disclosure is defined not by the detailed description, but by the claims and their equivalents, and all variations within the scope of the claims and their equivalents are to be construed as being included in the disclosure.

What is claimed is:

1. A sensor actuator comprising:
- an image sensor configured to convert incident light into an electrical signal; and
- first and second driving parts, configured to move the image sensor in first and second directions, respectively, each of the first and second driving parts comprising one or more drivers,
- wherein the one or more drivers further comprise:
- a lever, connected to the wire, configured to rotate around a rotation axis based on the change in length of the wire to move the image sensor;
- wherein the second driving part is configured to move the image sensor and the first driving part together; and
- the first and second directions are different from each other.

2. The sensor actuator of claim **1**, wherein the one or more drivers further comprise:
- a lever shaft forming the rotation axis.

3. The sensor actuator of claim **1**, wherein a moving distance of the image sensor based on the change in length of the wire is greater than an amount of the change in length of the wire.

4. The sensor actuator of claim **2**, wherein the lever comprises a connection portion connected to the wire, and a contact portion contacting a plate provided with the image sensor, and
- the rotation axis is between the connection portion and the contact portion.

5. The sensor actuator of claim **4**, wherein in the lever, a distance from the connection portion to the rotation axis is smaller than a distance from the contact portion to the rotation axis.

6. The sensor actuator of claim **4**, wherein the contact portion of the lever has a curved surface.

7. The sensor actuator of claim **1**, wherein the first direction is a first axis perpendicular to an optical axis, and
- the second direction is a second axis perpendicular to both the optical axis and the first axis.

8. The sensor actuator of claim **7**, wherein the first driving part comprises:
- a movable plate configured to movably accommodate the image sensor;
- a first lever, disposed on the movable plate, configured to move the image sensor in a positive direction of the first axis; and
- a second lever, disposed on the movable plate, configured to move the image sensor in a negative direction of the first axis.

9. The sensor actuator of claim **8**, further comprising a sensor plate surrounding a perimeter of the image sensor,
- wherein the movable plate comprises a first guide portion extending in the direction of the first axis,
- the first guide portion comprises a first extension portion extending from the movable plate in a direction of the optical axis, and a first bent portion bent from the first extension portion in a direction intersecting the optical axis, and
- at least a portion of the sensor plate is inserted between the first bent portion and the movable plate to move the sensor plate in the direction of the first axis.

10. The sensor actuator of claim **9**, further comprising a friction reducing member on the portion of the sensor plate inserted between the first bent portion and the movable plate.

11. The sensor actuator of claim **8**, wherein the second driving part comprises:
- a base configured to movably accommodate the movable plate;
- a third lever, disposed on the base, configured to move the movable plate in a positive direction of the second axis; and
- a fourth lever, disposed on the base, configured to move the movable plate in a negative direction of the second axis.

12. The sensor actuator of claim **11**, wherein the base comprises a second guide portion extending in the direction of the second axis,
- the second guide portion comprises a second extension portion extending from the base in a direction of the optical axis, and a second bent portion bent from the second extension portion in a direction intersecting the optical axis, and
- at least a portion of the movable plate is inserted between the second bent portion and the base to move the movable plate in the direction of the second axis.

13. The sensor actuator of claim **12**, further comprising a friction reducing member disposed on the portion of the movable plate inserted between the second bent portion and the base.

14. The sensor actuator of claim **11**, wherein the first, second, third, and fourth drivers are driven independently of each other.

15. A camera module comprising:
- a lens module comprising one or more lenses; and
- a sensor actuator, configured to receive incident light passing through the lens module, comprising:
- an image sensor, a movable plate, and a base stacked in a direction of an optical axis;
- a first wire configured to move the image sensor with respect to the movable plate in a direction of a first axis perpendicular to the optical axis; and
- a second wire configured to move the movable plate with respect to the base in a direction of a second axis perpendicular to both the optical axis and the first axis,
- wherein the first wire is disposed on the movable plate, and
- the second wire is disposed on the base,
- wherein the image sensor is movable along the upper surface of the movable plate, and
- wherein the movable plate is movable along with the upper surface of the base.

16. The camera module of claim **15**, wherein at least a portion of the first wire is disposed to extend in the direction of the second axis, and
- at least a portion of the second wire is disposed to extend in the direction of the first axis.

* * * * *